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ENVIRONMENTAL QUALITY COUNCIL

FIRST ANNUAL REPORT

OCTOBER 1972

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ACKNOWLEDGEMENTS

[illegible]

[illegible]

The production of this report was
financed by the
Environmental Protection Agency
Under Contract No. 68-01-0576

LETTER OF TRANSMITTAL

Honorable Forrest H. Anderson
Governor
State of Montana

Members of the Legislative Assembly

The People of Montana

The Environmental Quality Council herewith submits its First Annual Report for the fiscal year ending June 30, 1972 in accordance with Section 69-6514 of the Montana Environmental Policy Act.

George Darrow
Representative George Darrow
Chairman

Fletcher E. Newby
Fletcher E. Newby
Executive Director

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Preface

One of the major actions of the 1971 legislature, with long-term significance for the future of the state, was enactment of the Montana Environmental Policy Act (MEPA).

In declaring a state policy for the environment, the legislature asserted the importance of using all practicable means and measures ". . . to create and maintain conditions under which man and nature can coexist in productive harmony." Further, the legislature accepted the obligation of the state to use all practicable means to ". . . fulfill the responsibilities of each generation as trustee of the environment for succeeding generations."

To implement MEPA, a 13-member Environmental Quality Council (EQC) was created and funded. The council functions as an arm of the legislature, with public participation and executive branch liaison. This structure is unique in the United States and is of major importance in the council's long-term success. The diversity of council membership assures that a broad perspective will be maintained in carrying out its assigned functions.

The EQC is not a regulatory agency. It is not an environmental control agency. Responsibility for these functions lies with various existing agencies in the executive branch of state government. Instead, the council's role is to anticipate environmental problems, analyze their root causes, perceive alternatives, and recommend preventive action.

It is a basic ecological insight that all environmental problems are interwoven, interrelated, and interacting. No project, no action by state government, has only a single consequence. However, most state agencies are responsbile for only a single primary mission. There has been a continuing need for a systematic way to deal with complex problems that cut across the responsibilities of several agencies.

The EQC has an important role in maintaining a policy overview of state programs with environmental consequences to assure that state environmental policy is consistently observed. It also fulfills the urgent need for a mechanism within state government to better coordinate and integrate the various environmental programs of state agencies already in existence. In the past, environmental problems have often been dealt with in a piecemeal manner because of the lack of such a mechanism. The Coal Task Force, recommended by the council and implemented by the governor, illustrates the council's coordinating, integrating role.

A principle tool of the EQC in implementing MEPA is the environmental impact statement. This is, in effect, a basic reform in state decision-making that opens to public scrutiny and participation a wide range of state activities with significant environmental consequences. By providing public visibility in the decision-making process, it promotes citizen participation in vital decisions that will have lasting impact on the lives of Montana people.

The objective of the council is to build up the environmental judgment of state agencies rather than to substitute its own. The requirements of an impact statement elevate environmental considerations to parity with economic and technical considerations. Each agency is then responsible for making its own balancing analysis after full disclosure of the consequences involved in its decision. In essence, the environmental impact statement process establishes systematic planning procedures to be observed by all state agencies in the interest of the long-term welfare of Montanans.

The Environmental Quality Council began its operations on September 1, 1971 with the hiring of Fletcher E. Newby as executive director. As demonstrated by the following report, the accomplishments of Mr. Newby and his small staff within the span of a single year are impressive. The council has been fortunate in the dedication of its members. Their contributions and wise counsel in making the difficult decisions of the EQC's startup phase will be of lasting value.

In the years to come, I believe the people of Montana will increasingly recognize the milestone action of the 1971 legislature in enacting the Montana Environmental Policy Act and the enduring benefit to the well-being of Montanans made possible by this action. On behalf of the council, I wish to express our appreciation for the opportunity to serve during this formative period.

Representative George Darrow
Chairman
Environmental Quality Council

Introduction

The First Annual Environmental Quality Report by the Environmental Quality Council documents the basis for broad public concern about problems of environmental quality. The Montana Environmental Policy Act, which established the council, became law on March 9, 1971. The act expressly instructs the executive director and staff to carry out a wide variety of duties and functions.

Gather timely and authoritative information —

Review and appraise programs and activities of state agencies —

Develop and recommend policies —

Conduct investigations, studies, surveys, research, and analyses —

Document and define changes in the natural environment —

Make and furnish studies, reports, and recommendations as the legislature requests —

Analyze legislative proposals —

Consult with and assist legislators —

Suggest legislation —

Transmit to the governor, legislature, and public an annual report containing.

The status and condition of the major environmental classes —

Current and foreseeable environmental trends —

The adequacy of available natural resources for future use —

A review of agency programs and activities—

A program for remedying deficiencies of existing programs with recommendations for legislation.—

The report describes baseline conditions of Montana environments, identifies problems, reviews agency environmental programs, and makes recommendations. In most instances, identification of trends in environmental conditions must necessarily await the accumulation of more information.

The diverse environments of Montana are ecological systems of air, water, land, energy, and life interlocking with socioeconomic systems to produce the cultural landscapes (land use) of the state. Environmental regions proposed in the report reflect this diversity: each consists of a unique composite of interrelating systems; each has a special combination of environmental problems. Natural resources, which overlap regional boundaries, are identified and their adequacy for fulfilling needs is discussed.

Man in the Montana environment is continually making decisions and undertaking actions that impinge upon ecological systems. The environmental impacts of these activities, and the conditions arising from them, are described for each region.

Man also makes decisions in his political and economic processes that are efforts to prevent, abate, or modify the undesirable consequences of such actions. Among these efforts is recent environmental legislation that recognizes, for the first time in Montana history, the dependency of man upon his life support systems. This legislation is reviewed, as are environmental protection efforts of private citizens. Segments of Montana industry have also supplied information in this context.

The activities of the Environmental Quality Council in its short life are presented. Implementation of the environmental impact statement requirements of the Montana Environmental Policy Act gives state agencies an effective tool for orderly decision-making and planning; at the same time it provides an avenue for constructive input from other agencies and the public. In addition to administering the environmental impact procedure, the Environmental Quality Council is instructed by the act to review and appraise state agency programs that affect the environment. Appraisals of several agencies are included.

On its own initiative or at the request of private citizens, organizations, agencies, or legislators, the Environmental Quality Council uses its investigative powers to promote compliance with the act or to disseminate information on environmental problems. The report describes the role of the council as environmental advocate and includes special studies conducted by the staff.

Much has been learned about the Montana environment since activation of the council staff on September 1, 1971. It is now possible to make a number of recommendations for new and improved legislation, programs, and policies.

The First Annual Environmental Quality Report is offered as a beginning upon which succeeding reports will build. Although it touches primarily upon major conditions resulting from the interaction of human activities with physical and biological surroundings, many additional opportunities for investigation have been identified. Future reports will consider current issues in greater detail and will explore others not covered in this publication.

Fletcher E. Newby
Executive Director
Environmental Quality Council

Chapter 1

THE PLACE

Environmental regions of montana

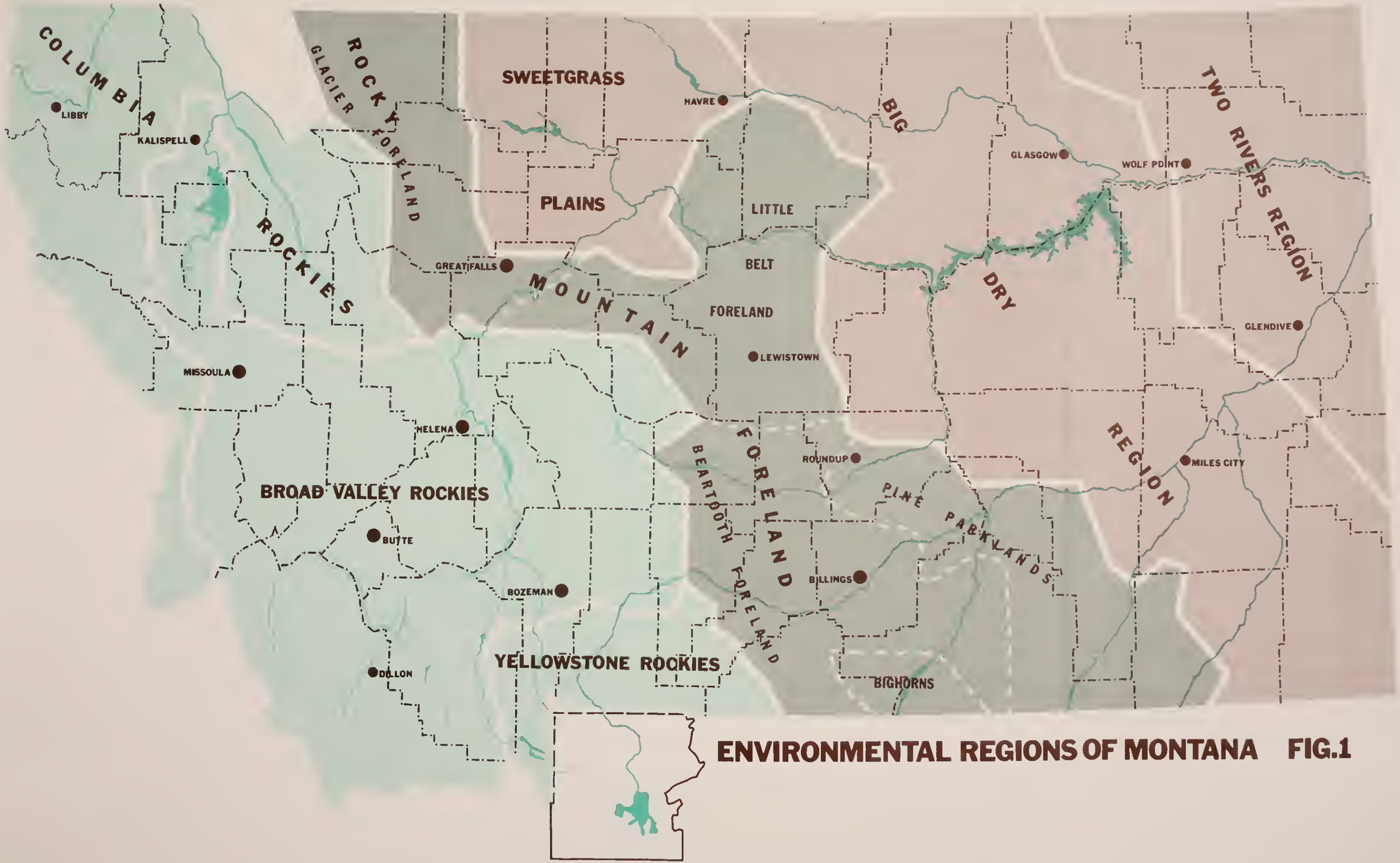
by
John M. Crowley

Introduction

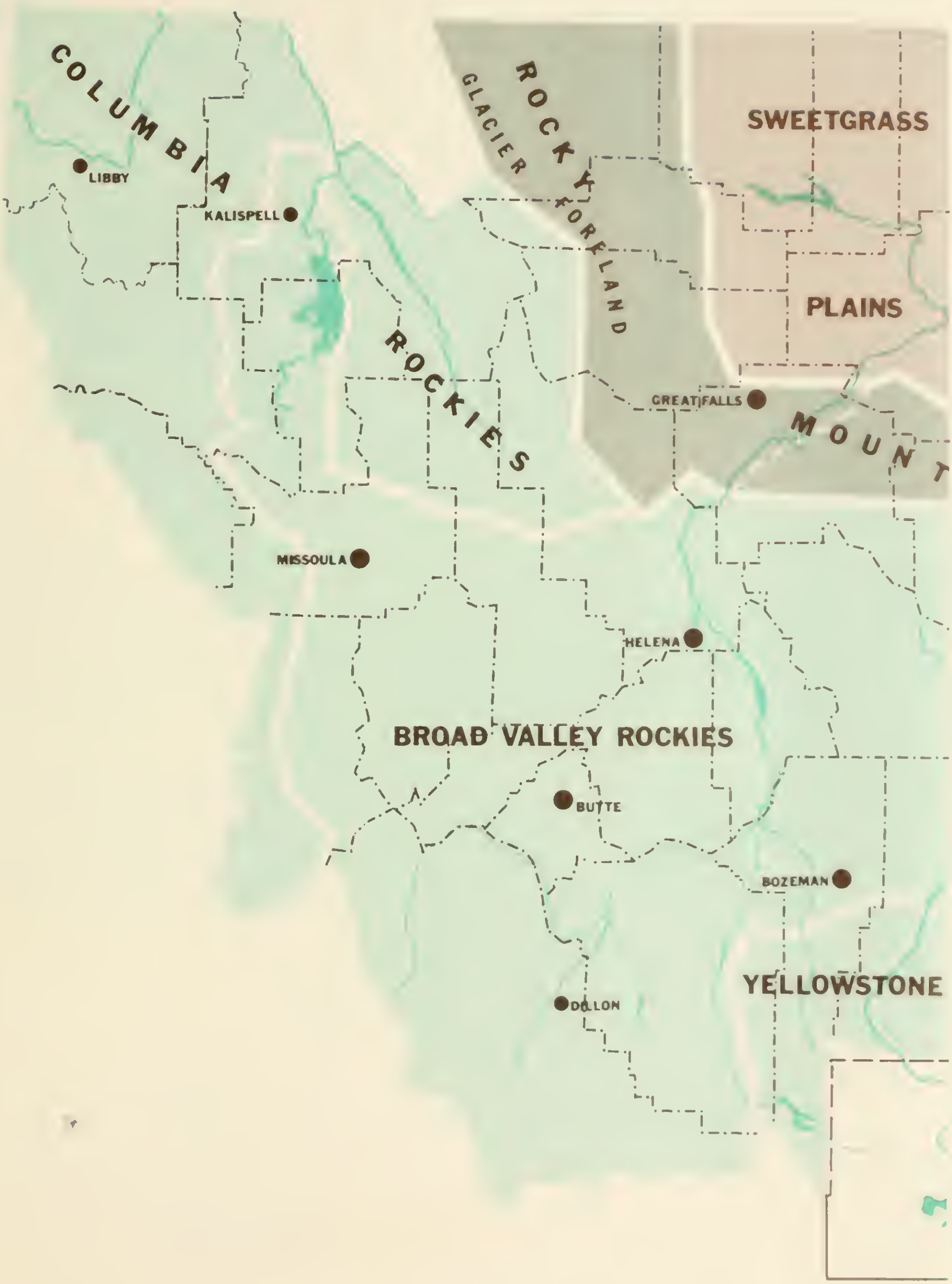
Our present human environment is the result of man's modification of the natural environment. Both the natural and the modified vary from place to place in Montana, as elsewhere in the world. This spatial variation is not haphazard. A particular kind of environment is usually associated with other kinds in such a way as to form a distinctive combination; for example, wheatfields, fallow fields, short-grass rangeland, and irrigated valleys in northeastern Montana. Such combinations of environments tend to recur throughout a broad area and thereby form an environmental region that differs sharply from neighboring regions.

We actually have two Montanas – Rocky Mountain Montana to the west and Great Plains Montana to the east. The first is a land of high mountains and deep valleys, green forests and sparkling waters, logging and sawmills, mines and smelters, pocketed irrigation and mountain grazing, spectacular alpine scenery, and nationally renowned parks and wilderness areas. The second is a vast expanse of plateaus and hills, plains and grasslands, yellow wheatfields and brown fallow strips, coal mines, oil wells, petroleum refineries, and widely spaced rivers flowing from the Rockies through rich cottonwood bottomlands and rugged breaks.

The boundary between the two Montanas is the eastern foot of the Rockies and is indicated by the distinct color change on the map (Figure 1). These two major sectors of Montana are sharply different human environments. Moreover, each of the two contains pronounced environmental contrasts within itself. These contrasts – between sectors and within sectors – give rise to the seven regions shown in Figure 1, regions which form the basis for our descriptions, analyses, and comparisons of the Montana environment.



ENVIRONMENTAL REGIONS OF MONTANA FIG.1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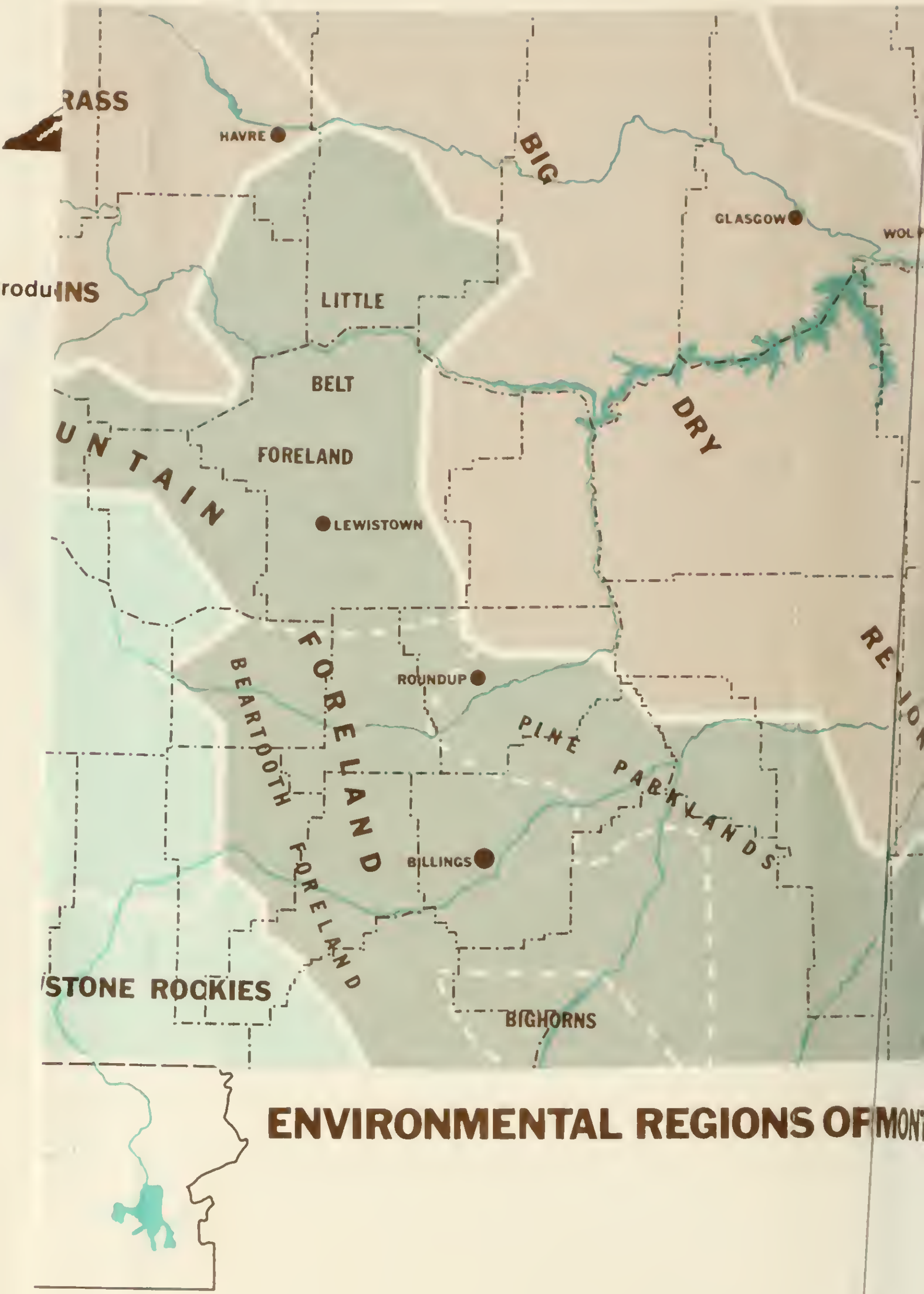
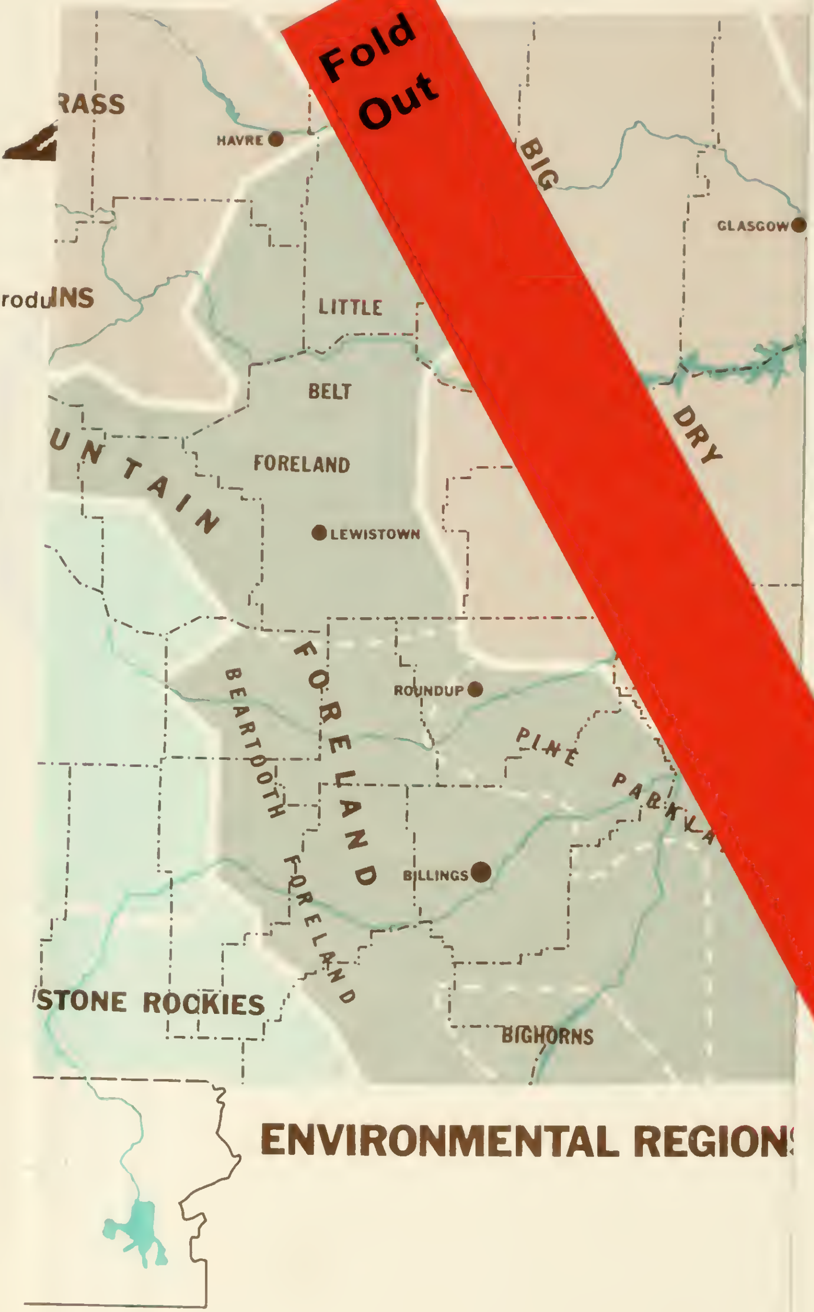
HELENA
BROAD VALLEY ROCKIES
BUTTE
BOZEMAN
YELLOWSTONE
DILLON



ENVIRONMENTAL REGIONS OF MONT

MONTANA FIG.1

Fold Out



ENVIRONMENTAL REGION

Rocky mountain
MONTANA

The Rocky Mountain sector is made up of mountain ranges generally trending north-south or northwest-southeast and commonly separated from the flat valley floors by an intervening belt of foothills or benchlands. This sector of the state has three environmental regions — the Columbia Rockies, the Yellowstone Rockies, and the Broad Valley Rockies.

Like all mountainous areas, Rocky Mountain Montana is three-dimensional. The vertical dimension is often the dominant one, and most of the land is in steep slopes. A brief review of the vertical aspects of environment is a necessary background for more detailed descriptions of the three environmental regions of the Rocky Mountain sector.

Altitudinal Zones

In mountainous areas, climate, vegetation, and soils are arranged in altitudinal zones. From the bottom to the top of a mountain range, atmospheric conditions become progressively cooler, windier, and more humid. These altitudinal zones are shown in Figure 2. In addition to elevation, the boundaries between zones are influenced by slope, aspect, and latitude.

The climate and general types of vegetation and soils in any given zone are very much the same from one mountain range to another. In Montana all of the zones have cold winters, the severity of the winter and the amount of snow increasing from the lower to the upper zones. The three lower zones — the semiarid steppe, the subhumid prairie parkland, and the humid montane — have warm summers.

Glacial: This uppermost zone is represented by permanent snow and existing glaciers, such as those of Glacier National Park and the Mission Range.

Subglacial: The subglacial zone has neither permanent snow nor appreciable vegetation. Here glaciation has produced bedrock escarpments, sharply pointed horns, saw-like crestlines between the horns, steep cirque walls, and coarse rock debris. The wind is exceedingly violent around the peaks.

Alpine tundra: The slopes of this zone are covered by alpine grasses, low shrubs, and wildflowers. The soil is thin, rocky, and interspersed with many rock outcrops. The climate is too severe for tree growth, summer freezes are common, and winds are usually strong. The tundra environment is fragile and easily deteriorated by excessive grazing, recreational use, or construction.

Subalpine forest: This zone is below timberline and contains dense or park-like stands of whitebark pine, limber pine, Engelmann spruce, and subalpine fir. It is the zone of greatest winter snow accumulation and is therefore the most important in terms of water supply. Occasional summer frosts exclude most agricultural crops.

Montane forest: Also a belt of coniferous forest, the montane zone is warmer, less humid, and less snowy than the subalpine. Midsummer frosts are rare. Where slope and soils permit, hardy agricultural crops may be grown. The montane and lower subalpine forests are the most important for commercial timber production.

Subhumid prairie parkland: This foothills zone is situated between the valley floors and the mountain slopes. The climate is humid, but less so than that of the montane forest. Because average water surplus is slight, the zone is not important in runoff or water supply.

Prairie parkland is characterized by prairie bunchgrass, savanna, and patches of forest. It provides the best nonirrigated grazing land in Montana, and dryland farming is successful on the smoother benches.

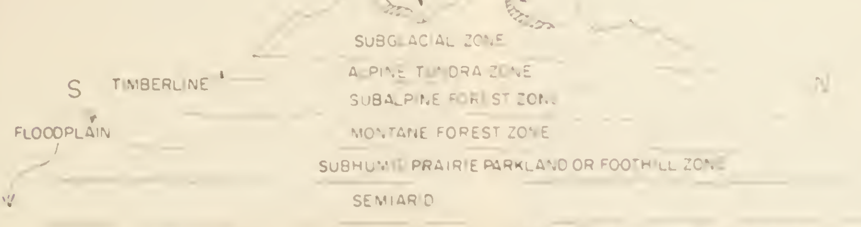


FIGURE 2 ALTITUDINAL ZONES OF MONTANA

Semiarid steppe: The climate of the steppe zone is dry but not arid, and the natural vegetation is short bunchgrass or, in a few valleys, sagebrush and bunchgrass. Since the steppe zone has a large water deficiency and no surplus, it is insignificant in runoff and water supply. Too dry for forest growth and for most agricultural crops, it is the zone in which most irrigated farming takes place.

Floodplain: The floodplain forests may be visualized as another altitudinal zone below the others. It is not the humidity of the ambient climate that supports these forests but rather the high water table, seasonal inundations, and generally moist soil conditions. Floodplain forests are composed primarily of cottonwood and, in western Montana, ponderosa pine. In higher valleys, such as the Big Hole, floodplain trees are absent and streams are bordered by thickets of willow and alder. Floodplains are suitable for recreation and, when cleared, for agricultural use, but because of the flood hazard, not for settlement.

Horizontal Arrangement of Landforms and Precipitation

The spacing of the mountain ranges and the horizontal distribution of precipitation are the key factors that give rise to the three environmental regions of Rocky Mountain Montana. The Columbia Rockies has very humid, severely glaciated mountains and narrow, moist valleys. The Yellowstone Rockies has fairly humid, heavily glaciated mountains and narrow, fairly dry valleys. The Broad Valley Rockies has less humid, less extensively glaciated mountains and broad, dry valleys. The boundaries between the Rocky Mountain Montana regions have been drawn on the basis of these factors.

Columbia rockies

The Columbia Rockies is a water supply, timber supply, recreation region. It is here that the glacial and subglacial zones are best developed and most conspicuous in Montana. A majority of the existing glaciers, permanent snowfields, and subglacial topography of the state is in this region. This northwestern area is also the most humid of the seven environmental regions of Montana, with the state's most abundant lakes and streams and most dense, diversified and luxuriant forests.

Forest types in the Columbia Rockies can best be described relative to the altitudinal zones outlined earlier. At timberline, whitebark and limber pine often form parklands, occasionally intermingled with the rare subalpine larch. In a few areas, such as the Cabinet Mountains, stands of mountain hemlock occur in the upper part of the subalpine zone. In the lower part, subalpine fir and Engelmann spruce are the stable or climax type. Seral forests of lodgepole pine and western larch exist in some areas where the fir-spruce forest has been removed by fire or logging.

In the montane zone of the Columbia Rockies, the climax types are western red cedar and western hemlock in the most humid situations, Douglas-fir in the least humid, and grand fir in the intermediate. When cut or burned, the cedar-hemlock and grand fir types are generally replaced by western larch, western white pine, Douglas-fir, or ponderosa pine.

Most of the valley bottoms of this region are in the montane zone and were formerly forested. Although sections of the valley floors have been cleared for settlement and agriculture, they can support forests of Douglas-fir or ponderosa pine. Only the sunny slopes in the least humid valleys, such as the Clark Fork Valley near Perma, fall in the subhumid prairie parkland zone.

This region was the most extensively glaciated of Rocky Mountain Montana; till plains and numerous moraines occur in valley bottoms, and many foothills are lateral and terminal moraines.

The Columbia Rockies is the most important timber-producing region of Montana and, because of its voluminous water supply, is also the state's most important region for hydroelectric power production. It contains four of the five largest dams in the state in terms of power capacity, and supplies the water that produces power at Kerr Dam, the sixth largest.

The magnificent mountains of the Columbia Rockies make it exceedingly attractive for tourism and all manner of outdoor leisure-time uses: its parks and wilderness areas, its many lakes, reservoirs, and streams, its relatively cool summers and heavy winter snows, are the basis for a variegated year-round recreational resource of exceptional quality.

None of these principal economic activities supports much population, however, and the region as a whole remains sparsely settled. Many of the tourist centers that serve the Columbia Rockies (Whitefish, Kalispell, Polson, Missoula, Hamilton, Browning, etc.), are in adjacent regions, and most of its logs are sawed elsewhere, in either Montana's Broad Valley Rockies or in Idaho. Libby (population about 4,000) is the largest town and principal sawmilling center of the Columbia Rockies. Wood processing is the region's only significant manufacturing industry, and it is less important here, in terms of total production, than in the Broad Valley Rockies. The major wood products centers aside from Libby are Eureka, Plains, Thompson Falls, and Superior. Virtually all Columbia Rockies towns are either sawmilling centers, such as those named, recreation towns, such as West Glacier and Coram, or transportation service centers, such as Paradise and St. Regis. Since the scant population is concentrated in linear strips in the narrow valley bottoms, it is generally quite dense in the settled areas.

ellowstone rockies

Here also is a region of water supply, timber supply, and recreation. Again like the Columbia Rockies, it has high mountains and narrow valleys. (The one exception is Paradise Valley, from Livingston to Gardiner on the upper Yellowstone River, which is similar to the wide, dry valleys of the Broad Valley Rockies.) Four mountain ranges trending more or less north-south make up most of the Yellowstone Rockies. From east to west these are the Beartooth, Absaroka, Gallatin, and Madison.

The alpine tundra and subglacial zones of the region are similar to those of the Columbia Rockies. The glacial zone is represented only by small remnants, such as Grasshopper Glacier in the Beartooth.

The Yellowstone Rockies differs from the Columbia Rockies in having less humid conditions, a less diverse and luxuriant forest cover, and a much less important wood-processing industry. (Most of the logs from this region are used outside, in sawmills at Livingston, Bozeman, and Belgrade.) Although lower precipitation, compared to the Columbia Rockies, results in a less abundant water supply, the region is nonetheless of great importance in this respect, providing much of the water in the Yellowstone River and some of that in the Missouri.

In the forests of the Yellowstone Rockies, cedar, hemlock, grand fir, white pine, and larch are entirely absent. Douglas-fir forest is the climax type throughout the montane zone, although, as a result of fires and logging, much of this zone is now occupied by lodgepole pine. The subalpine zone is dominated by subalpine fir and Engelmann spruce, with lodgepole pine as the principal seral type.

The Yellowstone Rockies is even more sparsely populated than the Columbia Rockies. The largest towns are Gardiner and West Yellowstone. Each has about 800 population, both are entrance points to Yellowstone National Park and have a recreation service function. West Yellowstone is, in addition, a minor logging and sawmilling center. The only other appreciable population is in the agricultural Paradise Valley.

The spectacular rugged peaks, heavily forested slopes, and abundant water give the Yellowstone Rockies great recreation appeal. The region englobes the Montana sector of Yellowstone National Park and three stunningly beautiful primitive areas — the Beartooth, the Absaroka, and the Spanish Peaks. The Yellowstone Rockies shares with the Columbia Rockies a wildlife value of special importance: most of the grizzly bear in Montana are confined to these two regions.

road Valley rockies

The Broad Valley region of Montana and its extensio in adjacent northeastern Idaho is an exceedingly rare typ of landscape in North America. Its balance of water supply forestland, grassy rangeland, irrigable land, an mineralized rock is to be found almost nowhere els Because of this combination of features, the Broad Valle Rockies is the most heavily populated area of the entir Rocky Mountain system. Montana is the only Rock Mountain state or province having its capitol, its majo universities, several of its principal towns and cities, an much of its manufacturing industry within the mountai chain.

The geographic basis of the unique environment of th Broad Valley Rockies is its topography — which geog raphers call open mountains — coupled with heavy bu not excessive precipitation in the mountain ranges. (I open mountains the valley bottoms occupy 20 to 50 per cent of the area. In mountains with narrow valleys, a in the Columbia Rockies, the valley bottoms account fo less than 20 percent of the surface. In basin-and-rang topography, as in Nevada, the basins occupy 50 to 75 per cent.)

Compared to mountains with narrow valleys, the broa valleys of open mountains provide more arable, irrigabl land and the unirrigated portions of the valley floors an the grassy foothills provide more grazing. Compared t basin-and-range topography, the more closely space ranges of open mountains supply more water and timbe Because of its open mountain pattern, the Broad Valle Rockies has a complex economy consisting of irrigate farming, livestock ranching, timber production, wood pro cessing, water supply, and recreation. To this must b added mining and associated metallurgy.

The Broad Valley Rockies rise from the steppe zone t the subglacial zone. The glacial zone is virtually absen The subglacial is conspicuous on some of the higher, mor severely glaciated mountains, such as the Anacond Range. Several of the higher mountain ranges have a extensive alpine tundra.

The subalpine and montane zones are similar to the corre sponding zones in the Yellowstone Rockies. Subalpine fi and Engelmann spruce are the stable type in the lowe subalpine, and Doublas-fir is the climax in most of th montane, with lodgepole pine a common seral type i both zones. However, the montane forest in the Broa Valley region is generally less luxuriant than in the Yel lowstone region, and ponderosa pine is much more abun dant as a seral type on cutover and burned-over Douglas-fi sites. The mountainsides have been scarred by roadbuild ing and mining operations, the forests have been greatly modified by logging and man-caused fires, and the understory of the less dense forests has been transformed by cattle grazing. As a result, seral stands of lodgepole pine, ponderosa pine, and, in a few areas, western larch are much more prevalent today than originally.

Subhumid prairie parkland is extensive in this region, whereas it is unimportant or absent in the two other regions of Rocky Mountain Montana. Nearly all of the broad valleys have remnants of basin-fill sediments, which present themselves as foothills or benchlands. Prairie parkland occupies most of these foothills and benches, extends some distance up the mountain slopes on sunny exposures, and sometimes descends onto the valley floors. Dryland farming is practiced on the smooth surfaces of the benches, especially in the Helena, Townsend, and lower Gallatin Valleys. The remainder of the land in this zone has been grazed since early settlement, and the climax perennial grasses have to a considerable extent been replaced by unproductive annual grasses and weedy species.

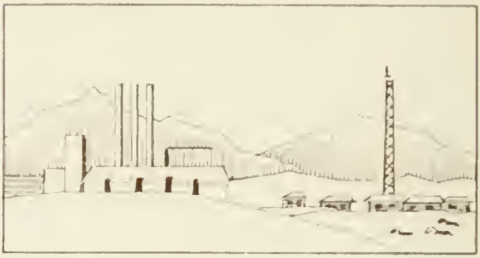
Much of the zone's ponderosa pine has been cut for lumber, and tree regeneration, under intensive grazing and sometimes burning, has been slow. Almost all of the mountain slopes are in national forests. The partially wooded foothills are attractive land for recreational and residential development. Summer cabins and country homes are proliferating in the prairie parkland zone, especially within commuting distance of the major cities and towns.

Most of the region's settlement and virtually all of its irrigated farming are in the steppe and floodplain zones. The natural vegetation types of the semiarid steppe were bluebunch wheatgrass in most of the valleys and this plus sagebrush in the Big Hole, Beaverhead, Centennial, Shields, and Smith River Valleys. The steppe zone occupies the valley terraces, the lower benches, and, in some of the driest valleys, the foothills and lower mountain slopes. The steppe grasslands have been modified by grazing, perhaps even more than have the prairie parklands. Sagebrush, other shrubs, annual grasses, and weedy plants have increased at the expense of the perennial bunchgrasses.

Seepage from irrigated fields on the floodplains and terraces has created additional sloughs and marshes in the low-lying areas. Many of the floodplain forests have been cleared for agriculture and settlement. The ponderosa pine has been cut from most of those that remain, leaving black cottonwood alone as the floodplain dominant. Extensive areas in the valley bottoms are occupied by man-made land, such as the Berkeley Pit and mine dumps at Butte, the smelter refuse and settling ponds in the Deer Lodge Valley near Anaconda, and the dredge tailings in Alder Gulch.

The urban-industrial environment is a major feature of the Broad Valley Rockies. Approximately one-third of all Montanans live in the four metropolitan areas of the state: Billings, Great Falls, Missoula, and Butte. The last two are in the Broad Valley Rockies. Of the 14 major cities and towns in Montana (the 12 regional trade centers recognized by the Department of Planning and Economic Development, plus Anaconda and Livingston), seven are located in this region. Among the principal manufacturing industries are the metallurgical complexes at Anaconda and East Helena, the aluminum plant at Columbia Falls, the phosphate and phosphorus plants at Garrison and Silver Bow, the talc plants at Three Forks and near Dillon, the pulp and paper mill and other wood-processing industries at Missoula, and the sawmills of other wood products centers such as Kalispell, Polson, Darby, Bozeman, Belgrade, Livingston, and White Sulphur Springs.

Missoula is in the eastern end of the Missoula Valley. From the central business district and older residential and industrial areas that straddle the Clark Fork at the mouth of Hellgate Canyon, suburban tentacles extend up the Rattlesnake and Pattee Creek Valleys to the north and southeast, onto the foothills to the south, and across the flat outwash terraces and floodplains to the southwest, west, and northwest. Missoula is a rapidly growing city, and serious urban deterioration is noticeable only in the northwestern part of the central business district and the older residential areas adjacent to it. With its suburban population and the nearby satellite villages of East Missoula, Milltown, Bonner, Lolo, and Frenchtown, metropolitan Missoula has a population of about 45,000.



Butte lies just west of the Continental Divide at about the midpoint of the Broad Valley Rockies. Its old downtown is on the side of "The Hill" only a few blocks from the giant Berkeley Pit. The older residential areas are spread around the central business district and extend up the hillside to include Walkerville. They are dotted by the shaft heads of the numerous mines underlying the city. Unlike Missoula, Butte is a declining city whose superstructure is too big for its population. Decreasing employment in the copper mines, dwindling population, and uncertainty about retention or abandonment of the old business district have caused severe deterioration of the downtown and older residential areas. The newer residential areas and the main commercial strip have been developed on "The Flat" southeast of the old town. With Walkerville and other neighborhoods outside the city limits, Butte has a metropolitan population of about 35,000.

The Broad Valley Rockies has a distinctive personality stemming from its physical and economic diversity. The panoramic views of mountain ranges across wide river valleys and undulating foothills, across Flathead Lake in the northern part of the region, give it a unique visual aspect.

All of the major sectors of the economy of the state except mineral-fuels extraction and oil refining are represented in the Broad Valley region. Economic activities, outdoor recreation, and urban development have drastically modified the natural environment.

Great plains
MONTANA

Great Plains Montana is a land of grassy plateaus, hills, and plains dotted here and there by partially forested mountain masses. Although many people think of the Great Plains as an endless flat expanse, genuine plains are the exception rather than the rule in this sector of Montana. Eastern Montana is in what is called the Missouri Plateau, which is one of the roughest parts of the Great Plains and contrasts sharply with the smooth plains of western Kansas and the Texas panhandle. Most of eastern Montana is classified as plateaus-and-hills, and even the genuine plains areas are either irregular or have widely spaced hills upon them.

The horizontal arrangement of natural features and types of land use gives rise to four environmental regions in Great Plains Montana — the Rocky Mountain Foreland, the Sweetgrass Plains, the Two Rivers, and the Big Dry. The Rocky Mountain Foreland is divided into five subregions: the Glacier, Little Belt, and Beartooth Forelands, the Bighorns, and the Pine Parklands (Figure 1).

Zones

Although Great Plains Montana is a much more horizontal area than the strongly three-dimensional Rocky Mountain Montana, the bioclimatic areas or belts of eastern Montana may be visualized as zones in the same general framework used for Rocky Mountain Montana (Figure 2). The concept of altitudinal zones applies to the mountain outliers and the foothills along the Rocky Mountain Front. (*Mountain outliers are referred to as such because their structure and rock types are like those of the Rocky Mountains and contrast sharply with types in the hills of eastern Montana, which are formed on rocks similar to those of the plains and plateaus.*) In the lowlands, each zone spreads out and occupies a broad area.

Montane Douglas-fir forest occurs on the higher slopes of the Rocky Mountain outliers and the Bighorns, and subalpine forest exists on some of the higher summits. The description of these zones in eastern Montana is similar to that given in the section on the Broad Valley Rockies.

Subhumid prairie parkland occupies the intermediate and sometimes the lower slopes of the mountain outliers and occurs as a more or less continuous bank on the higher land along the foot of the Rockies. Most of the zone is characterized by bluebunch wheatgrass and fescue prairie. The hills east and north of Billings and Hardin contain extensive ponderosa pine savannas and woodlands, most of which are included in the Pine Parklands subregion of the Rocky Mountain Foreland. Smaller parkland areas occur on the plateau east of the Snowy Mountains and in the plains-with-hills area east of Big Timber.

The rest of Great Plains Montana — the plains, plateaus, and remaining hill areas — falls entirely within the semiarid steppe zone, which can be easily divided into two subzones. The less dry of the two is mixed-grass steppe (western wheatgrass, needlegrass). This type occurs mainly in northeastern Montana, where it characterizes the Two Rivers region. The drier of the two subzones is short-grass steppe (blue grama, western wheatgrass, needlegrass). Semiarid steppe occupies virtually all of the Big Dry and Sweetgrass Plains regions and the drier parts of the Beartooth Foreland.

Floodplain forests along the major rivers of Great Plains Montana differ from those of Rocky Mountain Montana in that they are dominated by eastern cottonwood rather than black cottonwood. Many of these forests have been cleared to make way for irrigated fields and pastures.

The winters of the semiarid steppe of eastern Montana are more severe than those of the valley bottoms of Rocky Mountain Montana. Not protected from cold Canadian air masses by the Rockies, Great Plains Montana experiences more frequent and intense cold waves. The chinook, with its warm dry winds from the mountains, is an important feature of the winter climate near the Rocky Mountain Front, especially in the Glacier Foreland and Sweetgrass Plains. Summers in eastern Montana are similar to those in the valley bottoms of the Broad Valley Rockies although much warmer than in the mountain ranges of western Montana. Maximum summer temperatures are occasionally higher than in the western valleys.

As noted earlier, Great Plains Montana is primarily an area of oil, gas, and coal production, dryland and irrigated farming, and livestock ranching. The principal manufacturing industries are oil refining at Billings and Great Falls and in or near most of the producing oil fields, livestock slaughter and meat packing in Billings, Great Falls, and several other centers, flour milling at Great Falls, Billings, and some of the larger towns, sugar refining at Billings and Sidney, and metallurgy at Great Falls.

Rocky mountain foreland

This environmental region is directly east or "in front of" the Rocky Mountains. It is a land of mountain outliers and partially wooded hills separated by grassy plateaus and plains. In terms of the diversity of its environments, the complexity of its economy, and the density of its population, it may be viewed as the eastern counterpart of the Broad Valley Rockies. Despite its great variety of physical and cultural features, which have led to the designation of its subregions, the Rocky Mountain Foreland has an overall unity that qualifies it as a region. The unity of the Foreland is derived from a fairly consistent repetition of the following characteristics: (1) relatively dense population (next to the Broad Valley Rockies it is the most heavily populated region of the state), (2) prairie-foothill ranching based to some extent on upland summer grazing in the Rockies and mountain outliers, (3) areas of dryland farming, (4) sizeable strips of irrigated farming along the streams near where they emerge from the mountain outliers, (5) pine parklands, and (6) the bold Rocky Mountain Front as a panoramic backdrop to the landscape. Although almost all of these features occur in some other region or regions of Montana, only the Rocky Mountain Foreland has this distinctive combination.

The two largest cities of Montana, Billings and Great Falls, are in the Rocky Mountain Foreland. In addition are Lewistown, one of the 12 regional trade centers of the state, and several smaller but nevertheless sizeable towns. Rural settlement is dense along the irrigated strips and moderately dense in the dryland-farming areas.

The recreational value of the Rocky Mountain outliers, the pine parklands, and the Bighorn Mountains is of special significance because these features are the nearest of their kind to residents of much of the Foreland itself, of other eastern Montana regions, and of North Dakota and points east.

A more thorough understanding of the diversity of the Rocky Mountain Foreland can be gained from the following description of its environmental subregions. The boundaries between these subregions are indicated by the heavy dashed lines in Figure 1.

Glacier foreland

Named for its proximity to Glacier National Park, this subregion is a plateau, or tableland, cut by widely spaced canyons and deeply incised valleys. It contains all but two of the characteristics of the Rocky Mountain Foreland as a whole, lacking only pine parklands and mountain outliers. Here the mountain backdrop, formed principally by the Lewis and Sawtooth ranges, is bold and unbroken.

The Glacier Foreland has irrigated districts along the Marias, Teton, and Sun Rivers. Alternating with such districts in the eastern half of the subregion are extensive stretches of dryland grain farming; these same areas are also extremely important for oil and gas production. In the western half are some of the best and most beautiful grassy rangelands in Montana, commonly dotted with aspen groves.

The principal smaller towns of the Glacier Foreland are Cut Bank, Conrad, Browning, and Choteau. Great Falls lies at the confluence of the Missouri and Sun Rivers in the southeastern corner of the subregion. The valleys of these rivers cut quite deeply into the plateau, whose upland surface is represented here by the high shale bench on which the International Airport is located and by the high till-covered bench north of the city. The central business district and older residential and industrial areas are on the low-lying till and shale plains of the Missouri. Although Great Falls is a rapidly growing city, it contains several deteriorating and dilapidated housing areas in the older part of town. Some of the western residential areas are on the floodable bottomlands of the Sun River. The major commercial strip development is 10th Avenue South, which, along with the southern residential areas of the city, is on a low shale bench that stands appreciably higher than the central business district. The northern residential district and the giant metallurgical complex cling to the sloping edge of the high bench to the north. Malmstrom Air Force Base forms the eastern terminus of Great Falls, which has a metropolitan population of about 75,000.

little belt foreland

All of the mountain outliers except the Sweetgrass Hills are grouped within this subregion, named for its position in front of the Little Belt Mountains. The outliers are the Bearpaw and Little Rocky Mountains southeast of Havre, the Highwood Mountains east-southeast of Great Falls, the Judith and Moccasin Mountains north of Lewistown, and the Big and Little Snowy Mountains south of Lewistown. All of these partially forested mountain masses stand upon a plateau, and one or more of them is visible from the upland surface virtually anywhere in the subregion. They give the visual dimensions of the Little Belt Foreland a mystical quality, made famous by the paintings of Charles M. Russell.

On the subregion's smaller plateau surfaces between the mountain outliers are areas of dryland farming. Tiny strips of irrigation occur in some of the incised stream valleys.

The rougher lands, notably the mountain outliers and the breaks of the Missouri, are used for livestock ranching. The Missouri Breaks, a wild and scenic free-flowing stretch of the river, is becoming increasingly important for its unique recreational and historic values. The Snowies and other mountain areas are also notable in terms of high-quality recreation. Lewistown, with 6,500 people, is the only sizeable town in the Little Belt Foreland. Rural settlement is appreciable and there are several villages.

Beartooth Foreland

The Beartooth Foreland is a basin-like area hemmed in by mountains and hills — the Bighorns to the south, the Beartooth Range to the southwest, the Crazy Mountains to the west, the Snowy Mountains to the north, and the hills of the Pine Parklands subregion in the east. Billings is located near the point of contact of the three principal landform types of the subregion: (1) plains with widely spaced high hills along the foot of the Rockies (west and southwest of the city), (2) plateau (north and east of the city), and (3) high hills with broad valleys (southeast of the city).

Irrigated strips occur along the Yellowstone, Clark Fork of the Yellowstone, Musselshell, Bighorn, and Little Bighorn Rivers. The bands of irrigation on either side of Billings are the broadest and most heavily populated of the Yellowstone Valley. A fairly large dryland-farming area has developed north of the Yellowstone between Billings and Big Timber. There are several smaller dryland-farming areas, such as around Hardin and across the river from Laurel. The nonfarming areas are used for ranching, and Billings is the largest livestock-auction, slaughter, and meat-packing center in Montana. Oil and gas are produced in the southwestern part of the subregion, near Red Lodge.

Most of Billings is in the bottom of the incised Yellowstone Valley at a point where the valley bluffs come nearly together to form an hourglass constriction. Conspicuous and attractive bluffs — the rimrocks — southeast and north of the downtown area are escarpments of the upland plateau surface. From the central business district and older residential and industrial areas just upstream from the constriction, newer residential areas and shopping centers stretch far to the west in the valley bottom. Although Billings may not be the fastest growing city in the state, it gives the impression of being Montana's principal boomtown. Nevertheless, parts of the urban environment are deteriorated, especially in the triangle formed by the central business district, the interstate, and the sugar refinery. On the south side of the Yellowstone immediately east of the valley constriction are some older residential developments and one of the oil refineries. Logan Field, the busiest commercial airport in Montana, is on the plateau surface above the rimrocks to the north of the downtown area. Extensive residential developments have grown up on the bench to the northeast as have a few above the bluffs to the south. Metropolitan Billings has a population of around 75,000, about the same as Great Falls.

Bighorns

The Bighorn Mountains are actually a part of the Rocky Mountains proper, although only the northern end of the range extends into Montana. Here the mountains are relatively low, only partially forested, and are more like the Rocky Mountain outliers than, for example, the bold Absaroka and Beartooth Ranges with their heavy forests and well-developed alpine features. Moreover, the Bighorns are separated from the Yellowstone Rockies by the very dry corridor connecting the Bighorn Basin of Wyoming with the Beartooth Foreland. Accordingly, in this review, the Bighorns are treated as a subregion of the Rocky Mountain Foreland rather than as a segment of the Rockies. The Pryor Mountains, a part of the Bighorn Range in the broad sense, are included in the subregion.

The Bighorn River cuts through the range, creating a spectacular canyon. Yellowtail Dam and Reservoir in Bighorn Canyon constitute the fourth largest hydroelectric power development in Montana; the reservoir is becoming increasingly popular for water-based recreation. The higher, wetter parts of the range support Douglas fir forest whereas the lower mountain slopes are covered by bluebunch-wheatgrass prairie. The scenically and historically interesting Pryor Mountains are the home of one of the few remaining herds of wild horses in the nation. The Bighorns subregion is sparsely populated. Fort Smith, with a scant 200 people, is its only agglomerated settlement.

Pine Parklands

This subregion is a jumble of high hills formed mainly on sandstone. A few areas of exposed soft shale rock have badland terrain, but most of the hills and valleys are covered by grass or by savannas and woodlands of ponderosa pine. The understory of these parklike stands is composed mainly of western wheatgrass, blue grama, and needlegrass.

The more heavily wooded portions of the Pine Parklands are the Bull Mountains (hills) near Roundup and the area west of Broadus. Logs from these areas supply several small sawmills, such as those in the towns just named and in Ashland and Lame Deer. The ponderosa parklands afford considerable grazing, and the treeless slopes are good grassy rangeland. Dryland farming is carried out in scattered locations on the more gentle terrain. There is little irrigation except along the Yellowstone River. The subregion provides excellent deer hunting.

Most of the Pine Parklands is probably underlain by subbituminous coal, and it is here that Montana's most active exploration, development, and strip mining for coal are currently being conducted. The subregion is one of the least heavily populated of the Rocky Mountain Foreland, Roundup and Forsyth, with populations of 2,200 and 1,900 respectively, are the only sizeable towns.

Sweetgrass Plains

Two Rivers

These two regions are environmentally similar, and were they not spatially separated would be considered a single region. They are the major grain, petroleum, and natural gas areas of Montana. The Two Rivers region is so named because the converging pattern of the Missouri and Yellowstone dominate much of its landscape.

Both regions are formed on more or less horizontal shales and sandstones, relatively young sedimentary rocks that are generally less hard and resistant than the old rocks of the Rocky Mountains. It is in the upwarps — arches or domes — of these rock layers that petroleum and natural gas are found. In the Sweetgrass Plains and the northern half of the Two Rivers, the rocks are covered by glacial till left by the continental icecap during the Ice Age. The topography of the till-covered areas is generally more rounded than that of the stream-eroded lands south of the limit of glaciation.

Wheat and increasing amounts of barley are grown by the use of giant machinery and dry-farming methods. Grain and fallow fields are usually laid out in alternate north-south strips, perpendicular to the predominant wind direction, giving these areas their special visual personality of yellow and brown rectangular patterns. This form of agriculture has greatly modified the natural environment, and the bare fallow strips are frequently a source of dust. Uncultivated land is used for grazing.

Major oil and gas areas of the two regions are the Sweetgrass Arch, near Shelby and the Sweetgrass Hills, and the Cedar Creek Arch, which stretches northwestward from Baker to beyond Glendive in the Two Rivers region. Oil fields of some importance, though without associated gas production, are scattered through the four counties of the northeastern corner of the state. Much of the Sweetgrass Plains is probably underlain by coal, and most of the Two Rivers is believed to be underlain by lignite.

The wheat and petroleum regions are the only large areas in Montana in which the rural population, villages, and towns are distributed more or less evenly over the land. The principal towns of the Sweetgrass Plains are Havre, Shelby, and Fort Benton. Those of the Two Rivers are Glendive, Sidney, Wolf Point, and Baker. Havre, with a population of 10,500, and Glendive, with 6,300, are among the 12 regional trade centers of the state, the other towns are principally agricultural service and transportation centers.

The two regions differ mainly by virtue of topography, bioclimate, and the kind of wheat grown. The Sweetgrass Plains in the only large area of genuine plains in Montana, whereas most of the Two Rivers is plateau. As might be expected, the Sweetgrass Plains has a higher proportion of land under cultivation.

The Sweetgrass Plains was formerly short-grass steppe. It receives only 55 to 65 percent of its annual precipitation during the growing season. Consequently it has a slightly drier summer and more snow than northeastern Montana. It produces both spring and winter wheat, relatively more barley than the Two Rivers, and less hay.

The Two Rivers was formerly mixed-grass steppe. It receives over 75 percent of its annual precipitation during the growing season. Virtually out of reach of the chinook, it has a colder winter (January average under 8°) than the Sweetgrass Plains (January average 12° to 20°). The Two Rivers grows spring wheat, barley, and hay, with very little winter wheat.

The regions' recreation attractions are the reservoirs and the segment of wild Missouri River in the Sweetgrass Plains, the numerous small lakes of the glaciated portion of the Two Rivers, the colorful Makoshika badlands near Glendive, and the hunting of plains animals, many of which use grainfields as a source of food.

Big Dry

The Big Dry is the largest environmental region of Montana — a great expanse of grassy rangeland traversed by two irrigated valleys and by Fort Peck Reservoir. It is named after Big Dry Creek to suggest the special quality of the region.

Most of the land is used for livestock ranching — both cattle and sheep — with some scattered areas of dryland grain farming. The short-grass rangelands of the Big Dry and other regions of eastern Montana have been greatly modified by grazing. This is especially significant in the case of the Big Dry because semiarid steppe occupies most of the region and is more fragile than prairie environments. The terrain is generally rough, till-covered plateau north of the Missouri, hills and plains-with-hills south of the Yellowstone, and stream-dissected plateau between the two rivers. The headquarters of the immense ranches are widely spaced and often marked by windmills in this land of intermittently dry streams. The villages of the exclusively ranching areas — such as Jordan, Broadus, and Ekalaka — show signs of decline and deterioration.

Most of the population and towns of the region are concentrated in narrow strips along the irrigated floodplains of the Yellowstone and Milk Rivers. The Milk River towns are Glasgow, Malta, Harlem, and Chinook. Miles City, with a population of 9,000, is the region's largest community and the only sizeable town along the Big Dry sector of the Yellowstone. It is these towns, rather than the villages mentioned above, that serve most of the ranching area as well as the irrigated strips. Miles City and Glasgow are among the dozen Montana regional trade centers. Glasgow, with less than 5,000 people, is the smallest of these.

Fort Peck Reservoir and the bordering breaks of the Missouri are a distinctive area within the Big Dry. The reservoir — largest in Montana — is a focus for water-based recreation in the region, which is otherwise generally lacking in this attraction. The hydroelectric power station at Fort Peck Dam is the seventh largest in the state.

The Big Dry accounts for a considerable proportion of Montana's oil and gas production. The major oil and gas areas are the Bowes and other fields near Chinook, the Bowdoin field northeast of Malta, the Musselshell area northeast of Roundup, and the recent Powder River developments near Broadus. Much of the southeastern half of the region is underlain by coal.

The Big Dry is one of the least populated regions of Montana and also one of the least used for activities other than ranching, irrigated farming, and mineral-fuels extraction. It has its own special beauty — superb vistas of spacious land and changing skies, scenic breaks and badlands, the mysterious wind-carved formations of Medicine Rocks State Park. The region provides some of the state's finest hunting for upland game birds, antelope, and deer. Fort Peck Reservoir and the adjoining river breaks are enclosed in the Charles M. Russell National Wildlife Refuge.

Montana resources

by
Thomas J. Gill

Introduction

Montana's great variety of natural resources adheres to no political boundaries or geographical classification. Although some are characteristic of Rocky Mountain or Great Plains Montana, a given resource usually occurs in two or more regions. To get a true picture of these resources, they must be viewed on a statewide basis; and to assess their future adequacy, one must bear in mind the social attitudes and economic goals of the people. Montanans, like most Americans, have traditionally exploited their environment. Recently, however, concern about the depletion and abuse of finite resources has focused attention on the need for a long-range approach to resource use.

This section of the chapter, responsive to Section 69-6514(j) (2) of the Montana Environmental Policy Act, identifies Montana's natural resources and briefly comments on their adequacy in light of projected requirements. Adequacy of the less quantifiable aspects of the state's resources, such as open space, to fulfill esthetic and spiritual needs will be discussed in Chapter II.

human resources

The 1970 census showed Montana's population as 694,409, an increase of three percent over 1960. Growth during the decade was concentrated mainly in the metropolitan areas, with Billings and Great Falls accounting for 85 percent of the state's increase. Nonmetropolitan areas increased their population by less than one percent. Counties in Rocky Mountain Montana generally gained, whereas Great Plains Montana, with the exception of Cascade, Yellowstone, Bighorn, Powder River, and Fallon Counties, decreased. An estimate based on the state's natural population growth suggests a net migratory loss of about 58,000 in the decade. Most were from nonmetropolitan areas (17).

Ninety-five to ninety-eight percent of Montana's residents are white, most of the rest are Indian. Although proportionally small, the nonwhite population increased at a much greater rate than the white population in the last 10 years.

Age composition of the 1970 population is different than that of 1960. The numbers of people in age groups under five and from 25 to 44 are significantly less, whereas large gains were recorded in the bracket from 15 to 24 years old. The reduction in the first two groups reflects selective out-of-state migration as well as lower birth rates during the depression years and in the 1960's. The increase in the numbers of people from 15 to 24 years old can be attributed to the "baby boom" after World War II.

The Montana Economic Study (5) predicts a 1980 population of 725,000. The study forecasts continued slow growth with net outmigration. This projected growth rate is subject to change, however, depending on forthcoming decisions concerning coal. Extensive development of coal in Great Plains Montana could cause a rapid population increase during the 1970's.

water resources

Most of Montana is semiarid. Only in the mountainous regions, particularly in the intermontane valleys, is water abundant throughout the summer. Surface water in the mountainous areas is of good quality; in the plains sector it is much more variable in both quality and quantity.

Montana is made up of parts of three major drainage systems. The Columbia River drains 17 percent of the state and provides 58 percent of the total stream flow. The Missouri River drains 82 percent of the state and provides 40 percent of the stream flow. The Hudson Bay drainage comprises less than 0.5 percent of the state and has about two percent of the discharge (20).

The state's four major river systems — the Kootenai-Flathead-Clark Fork (Columbia), Missouri, and Yellowstone — discharge 30 million to 40 million acre-feet per year (3). The surface water supply is derived primarily from runoff, which varies from 0.25 inches per year in the eastern half of the state to more than 40 inches in the western mountains, with an annual statewide average of 3.5 inches (20). Groundwater discharge is also a significant source of surface water, especially during the winter months.

Agriculture presently consumes more water than any other use, while hydroelectric generation is the largest nonconsumptive application. Other major uses include industrial processing, thermal generation, domestic supplies, and recreation.

A conflict among energy companies is likely in the Fort Union coal fields of eastern Montana. According to the Bureau of Reclamation, of the 2.9 million acre-feet of available water from the Yellowstone River and its tributaries about one million acre-feet has been optioned for use in thermal generation plants (12, 19). This plus the development of a comparable-size gasification industry, which also requires large quantities of water, could consume up to 75 percent of the available water (11). The supply may be further reduced if the coal reserves of the Fort Union Basin undergo even more extensive development than now projected in the North Central Power Study (12). Competition for the remaining water could become intense as these industries expand.

Unconsolidated valley fill constitutes the largest groundwater reservoir in Montana. This is especially true in the montane valleys of Rocky Mountain Montana, which in some cases contain several thousand feet of alluvium and lakebed sediments. Well production in this sector varies from one gallon to 2,000 gallons per minute, and the water quality is consistently good (20). Valley alluvium east of the Continental Divide is much thinner but does provide a reliable source of domestic and livestock water. Low inner-valley terraces composed of gravel, sand, and silt also provide an easily recharged groundwater reservoir.

Mesozoic and Cenozoic sediments east of the divide are the important bedrock aquifers. These formations are exposed on the flanks of many outlying mountain ranges and are favorably situated to receive recharge water, thus permitting artesian wells in many low-lying portions of eastern Montana.

Groundwater reserves are adequate to meet livestock and domestic requirements, but more work will be needed to determine their sufficiency for the heavy demands of industry and irrigation farming.

Mineral Resources

Copper

Copper deposits are scattered throughout Rocky Mountain Montana, but 99 percent of the production has come from the Butte District. Even though copper has been mined for 90 years at Butte, the district may support a 100,000-ton annual production for an indefinite period (20). Total reserves are estimated to be more than nine million tons (13). Copper-bearing locations outside the Butte District include the Hellgate and Radersburg Districts in Broadwater County, the Basin, Boulder, and Wickes Districts in Jefferson County, the Hecla and Utopia Districts in Beaverhead County, the Heddleston District in Lewis and Clark County, the Philipsburg District in Granite County, the Neihart District in Cascade County, and the New World District in Carbon County. Copper production from these districts has been of minor importance in the past, and they probably offer little in terms of future reserves.

In the last few years mining companies have conducted investigations in Lincoln County, the Beartooth Range, and near the town of Lincoln. Reserve estimates have not been released, but the deposits will probably support open-pit operations under proper economic conditions. Copper mining is not now under way in these areas.

Gold

Montana's gold, except for the Precambrian deposit at Jardine, is associated with late Cretaceous and Tertiary igneous intrusives. Currently, much of the state's gold is recovered as a byproduct of base metals, chiefly in the Butte District. Placer mining has virtually ceased to exist, and lode mining is now confined to small operations. Gold reserves appear adequate to support mining only on a very limited scale.

Silver, Zinc, and Lead

In Montana these minerals are usually found in association with igneous rocks of intermediate to acidic composition. The greatest percentage of silver has been and will continue to be recovered as a byproduct of copper in the Butte District. The large size of the Butte deposit assures the state's continuation as a major silver producer. Zinc and lead, unlike silver, are more independent of copper since they are recovered from the periphery of the enrichment zone. The largest reserves are in the Butte District although substantial deposits occur in other areas. Production of lead and zinc is likely to vary from year to year but any significant increase will probably have to await higher price levels.

Antimony, Arsenic, Bismuth, Cadmium

An antimony mine is presently in operation on Prospect Creek near Thompson Falls. Production figures and reserve estimates are unavailable at this time.

Montana has no deposits that are worked exclusively for the recovery of arsenic, bismuth, or cadmium. They are found in low concentrations associated with other ores and in Montana are recovered chiefly as byproducts of the Anaconda Company's copper operation in the Butte District. Bismuth and cadmium are in relatively short supply nationwide.

Chromite

Montana contains 80 percent of total United States chromite reserves. A large part of this state's reserves is found in the Stillwater Complex on the north flank of the Absaroka-Beartooth Range in the Yellowstone Rockies. The deposit is classified as a stratiform type and contains an estimated 2,520,000 long-tons of Cr_2O_3 (20). Two small podiform deposits occur near Red Lodge (Carbon County) and Sheridan (Madison County) and have estimated reserves of 4,600 and 1,000 long-tons respectively (20). At present no domestic chromite deposits can compete with imports because of low grade, small size, and/or remote location.

Iron

The largest iron reserves in Montana occur in Precambrian gneisses east and northeast of Dillon, where several deposits with an iron content of about 30 percent lie within a few miles of each other. Several other small deposits of detrital magnetite and magmatic iron in various places throughout the state are of unknown importance. In general, Montana's deposits appear adequate to support a moderate-size iron and steel industry, but distance from markets and limited local demand are currently prohibitive.

Tungsten

Montana has tungsten deposits of two types — veins and tactite. Veins are associated with igneous intrusives and are generally scattered, spotty, and of marginal grade. Tactite deposits in southwestern Montana are much more extensive and might be of commercial grade under certain economic conditions, but do not appear sufficient to sustain large-scale production.

Manganese

The Phillipsburg District contains the state's principal manganese deposit, with an estimated 710,000 tons (20). This source is the only domestic manganese suitable for use in dry-cell batteries, but it is not now being worked. The Butte District also has a significant reserve of manganese carbonate.

Asbestos

Deposits of asbestos have been reported in Gallatin, Madison, Beaverhead, and Lincoln Counties, the largest of which is associated with the Rainy Creek vermiculite deposit near Libby. No attempt has been made to market the material.

Clays

Clay is found in a variety of types, the use depending upon the type and quality. The South Moccasin Mountains contain a deposit of high-quality white-firing dickite clay, but distance from markets and transportation costs are prohibitive. Clays used as refractories in Anaconda's furnaces are mined near Anaconda. Clays of brick, tile, and ceramic grade occur in a number of places throughout the state, as do expandable clays used in a lightweight concrete aggregate.

Bentonite, present in much of Great Plains Montana, is a commercial name given to a clay made up primarily of the mineral montmorillonite, which swells when wet. Such clay can be used in drilling muds and as a reservoir sealant, bonding agent, paper filler, and binding agent in pelletizing iron ore. In the 1950's high-quality bentonite was removed from the Mowry Shale near Alzada. Other deposits are found in Bighorn, Rosebud, Treasure, and Valley Counties but are generally of poorer quality than that at Alzada. The only mine presently operating is near Vananda in Rosebud County. Although distance from markets has restricted development, the bentonite beds of eastern Montana may be a valuable future resource (21).

Fluorspar

Montana's fluorspar is associated with the Idaho batholith in western Montana, the Boulder batholith in southwestern Montana, and the potassium-rich igneous intrusives in central Montana. The largest commercial deposit is at Crystal Mountain in Ravalli County. Other deposits have either been exhausted or are in concentrations too small to be of economic value. Fluorine is also found in carbonate-fluorapatite, which is mined as phosphate rock. The mineral is concentrated in the Phosphoria Formation in the Broad Valley Rockies. The tonnage of phosphate rock treated is great enough to make Montana an important source of fluorine.

Gems and Gem Material

A variety of these are found in the state, of which sapphires are the most valuable. The highly prized "cornflower blue" sapphire occurs in several places but is especially characteristic of Yogo Gulch in Judith Basin County. Reserves in this area are thought to exceed previous production ($2.5 million uncut) (20). Sapphires have also been extracted from gravel along the Missouri River northeast of Helena, Magpie Gulch east of Helena, Rock Creek near Phillipsburg, and Dry Cottonwood Creek in Deer Lodge County. Other gem materials, found in a number of places, include moss agate, amethyst, alamandine garnet, rhodochrosite, quartz, silicified wood, and calcite. Most of these materials are not commercially utilized and reserves are generally unknown.

Gypsum

Gypsum, which occurs in four different formations in the state, is of minor economic importance. Reserves appear large enough to last for many years, but Montana's industry depends on price and demand rather than on presence of the raw material.

Limestone

Limestone is abundant in many places throughout the state in strata of nearly every geologic age. The Meagher, Mission Canyon, and Lodgepole Formations, exposed in the Rocky Mountain Foreland and the Broad Valley Rockies, are the major sources of the stone. Uses of limestone include cement aggregate, roadstone, flux, agricultural lime, railroad ballast, riprap, and fill material. Commercial utilization depends upon accessibility, desired use, and local demand. Reserves seem adequate to meet future needs.

Stone

Dimension stone and crushed stone are the primary industrial products. Crushed stone is made up of irregular fragments used principally for concrete aggregate, roadstone, and railroad ballast. Dimension stone consists of natural blocks or slabs that are cut to definite sizes and shapes for such things as columns, monuments, steps, etc. Limestone, marble, granite, and gneiss are the important dimension stones, while crushed or broken stone is derived from many rock types.

A number of quarries are operating in central and western Montana. Cascade and Park Counties have been the leading stone producers; each listed three quarries in 1963. Dimension stone is often mined only to supply the material for a specific project, and the quarry is abandoned upon completion. Montana's stone supplies are probably adequate to meet all foreseeable requirements.

Sand and Gravel

These materials, primarily of fluvial and glacial origin, are plentiful throughout Montana. The price per ton is low, and transportation costs restrict long haulage. This results in numerous small operations supplying local demand.

Phosphate

The Phosphoria Formation of Permian age in the Broad Valley Rockies constitutes the state's entire phosphate supply. The deposits are thickest in the vicinity of Lima and thin gradually to the north and east, pinching out near Drummond and Three Forks. Total phosphate reserves are estimated to be in excess of 24 billion tons (20).

The Institute of Ecology (4) indicates that if present trends continue, all known phosphate reserves will be exhausted before the end of the twenty-first century. It further observes that without phosphate fertilizers the world's agricultural resources could support only two billion people. As the supply dwindles in other regions, Montana's reserves will become increasingly important.

Talc

Montana possesses extensive reserves of steatite (the purest common commercial grade of talc) in the Precambrian metamorphic rocks of Beaverhead and Madison Counties. Steatite, in the form of stringers, veins, and large masses, is used primarily in the manufacture of electrical equipment. The largest quantity has come from the deposit on Axis Creek southeast of Dillon. The commercial potential of most deposits is currently unknown.

Vermiculite

Vermiculite is a brownish-green magnesium-aluminum silicate with a micaceous cleavage. It is used as an insulator, a lightweight cement aggregate, and for other purposes. A deposit at Libby is the principal source of vermiculite in the United States. Reserves are not precisely known but are considered sufficient to support an annual operation of 100,000 tons for several years (13). Noncommercial deposits occur in Hill, Ravalli, Madison, and Beaverhead Counties.

Energy resources

Montana's major geologic structures producing oil and gas are the Powder River Basin, the Williston Basin, the Bighorn Basin, the Sweetgrass Arch, the Bearpaw Uplift and the Big Snowy Uplift, all located in Great Plains Montana.

Oil production in 1970 amounted to nearly 38 million barrels, a reduction from the 1968 and 1969 volumes attributable primarily to declining production in the Bell Creek field. However, further applications of secondary recovery techniques, which account for 25 percent of Montana's crude oil, are expected to increase future production (10).

Total crude oil reserves in Montana's established fields, as of January 1, 1972, were estimated to be 425,114,000 barrels (10). New horizons showing promise are the Madison Formation in the Elk Basin field and the Red River Dolomite in the Williston Basin.

Natural gas production in 1970 amounted to nearly 57 billion cubic feet (10). The most active area at present is the Tiger Ridge field (Little Belt Foreland), described as the biggest gas discovery since 1950. Montana is unlikely to experience any gas shortage in the near future, but prospects for developing additional supplies do not appear good (5).

In 1967 Montana had an installed hydroelectric capacity of 1,659 megawatts (5). Completion of Libby Dam will increase the total by about 285 megawatts (13). About half of the state's electricity is generated by large public power plants such as Hungry Horse and Yellowtail Dams.

Montana west of the Continental Divide has the greatest number of possible sites for future hydroelectric installations. The Columbia-North Pacific Framework Study (17) outlined 12 such sites in the state's Columbia River drainage.

Montana's principal uranium reserves are located in two geologic strata, the lignite in the Two Rivers and Big Dry regions and the Phosphoria Formation in the Broad Valley Rockies. Concentrations are low, but given sufficient demand these deposits could become commercially valuable.

Thorium occurs in quartz veins in the Lemhi Pass area, in the Upper Cretaceous sandstones of Glacier, Pondera, and Lewis and Clark Counties, and in an occasional placer. The largest reserves, an estimated 100,000 tons of ThO_2, are in the Lemhi Pass vicinity, but current demand does not justify development (20).

Very little investigative research has been done on geothermal energy in Montana, thus the commercial potential is generally unknown.

The state's coal resources are covered in the report on eastern Montana's coal development potential in Chapter V, under staff investigations.

Timber resources

Forests cover almost 22 million acres in Montana and comprise one-fourth of the state's total land. Montana forestlands can be divided into commercial (over 77 percent), nonproductive (16 percent) and reserved (six percent). The federal government owns 68 percent of the commercial forest, while 28 percent is privately owned and four percent is owned by the state. The commercial forests are made up of 8,284,000 acres of sawtimber, 6,311,000 acres of poletimber, 1,576,000 acres of seedlings and saplings, and 1,129,000 unstocked acres. The Columbia Rockies contains about 51 percent of Montana's forestland and, as noted previously, is generally more productive than other regions.

The forest products industry ranks third in the production of gross income in Montana and is based primarily on Douglas-fir, western larch, ponderosa pine, lodgepole pine, spruce, and true firs. Douglas-fir, larch, and ponderosa pine are presently harvested at a rate above the allowable cut, while lodgepole pine, spruce, and true firs are taken at a rate far below the permissible limit (2). According to the timber industry, markets for this latter group of trees would make a large resource more productive while improving many timber stands.

Management of Montana's timber resources has come under heavy criticism. A recent study of the Bitterroot National Forest by the University of Montana concluded:

"Quality timber management and harvest practices are missing" (22). Overcutting occurs near many communities supported by sawmills with installed capacities larger than the allowable cut. Large tracts of commercial forestland denuded by fire and timber harvest in the last several decades remain unstocked.

Agricultural resources

Montana has nearly 15 million acres of cropland that in 1969 produced approximately $300 million worth of wheat, barley, oats, flax, hay, sugar beets, potatoes, and other crops (6). As described in the foregoing section, irrigated cropland is concentrated in the valleys of the major rivers throughout the state, whereas most dry farming takes place in the Sweetgrass Plains, Big Dry, and Two Rivers regions.

The Montana Soil and Water Conservation Needs Inventory for 1970 (15) has classified land into eight types based on production capability, crop choices, and management options. Class I lands have deep, well-drained soil and few limitations that restrict their use, and Class VIII is barren land such as bedrock exposures and unreclaimed spoilbanks not suitable for plant production. As can be seen from the following breakdown, a large percentage of Montana's cropland falls between these two extremes (15).

	Dry (89 percent)	Irrigated (11 percent)	Total
Class I	0	207,872	207,872
Class II	2,489,795	590,947	3,080,742
Class III	8,356,989	380,022	8,737,011
Class IV	1,458,477	308,161	1,766,638
Class V	15,871	1,478	17,349
Class VI	995,051	159,286	1,154,337
Class VII	24,826	0	24,826
	13,341,009	1,647,766	14,988,775

Pasture and rangelands comprise about 43 million acres (15) in Montana and support about three million cattle, one million sheep, and lesser numbers of other livestock (6). The majority of these lands have been placed in Classes III, IV, VI, and VII and are quite evenly distributed throughout the state. Forestlands are also a valuable source of livestock forage, since many timber species permit an understory of palatable grasses.

Outdoor recreation resources

Land under this classification includes wilderness and primitive areas, national and state parks, wildlife refuges, wild rivers, and ski areas. In general, it includes anything that offers an opportunity for recreation in an outdoor setting.

Approximately 1.5 million acres in Montana's 11 national forests have been classified as wilderness and are part of the National Wilderness Preservation System. These areas are roadless tracts characterized by natural conditions and containing a great deal of the state's most spectacular mountain scenery. Montana wildernesses include the Anaconda-Pintlar, the Cabinet Mountains, the Bob Marshall, the Gates of the Mountains, and the eastern portion of the Selway-Bitterroot. The Absaroka, Beartooth, Mission Mountains, and Spanish Peaks Primitive Areas, consisting of a total of about 420,000 acres, are under consideration for inclusion in the wilderness system (18). The Lincoln Back Country has recently been designated as the Scapegoat Wilderness, and numerous other Montana wildlands are qualified for wilderness classification.

Some of Montana's public domain lands, administered by the Bureau of Land Management, are also outstanding natural areas. Three BLM primitive areas have recently been designated.

The two national parks in Montana — Glacier and the northern portion of Yellowstone — are located in areas of unique natural features. Although the parks draw millions of visitors each year, they still contain large tracts of undisturbed land that provide some of the finest wildlife sanctuaries and wilderness recreation in the world. Glacier Park comprises about 87 percent of the 1.15 million acres of national park land in Montana (14).

Montana also has a number of other areas set aside for the maintanance of natural or seminatural conditions. They include seven national wildlife refuges, two wildlife ranges, and two current candidates for inclusion in the National Wild and Scenic Rivers System. The two proposed wild rivers are the upper Flathead and the Missouri between Fort Benton and Fort Peck Reservoir.

The State Fish and Game Department administers state parks, recreation areas, and fishing access sites. The 43 state parks and recreation areas are used for a variety of recreation activities; the parks are generally related to unique attractions of statewide significance (7). The 97 fishing sites provide access to major lakes and rivers and in many cases camping and picnicking opportunities as well. The state also has 26 ski areas, most of which are private developments.

Montana contains thousands of acres of land used for recreation, notably nonwilderness national forestland, that are not included in the above brief outline. As more people become aware of the recreational potential of this state, its resources and facilities will come under increasing pressure. The demand for outdoor recreation is expected to triple by the year 2000 (2). Because Montana is one of the few remaining states containing significant amounts of relatively unspoiled natural environment, demand by both residents and nonresidents will probably increase at an even more rapid rate.

Historic and Archeological resources

Historic and archeological sites are an important nonrenewable resource that is commonly overlooked. The large number of sites in Montana prohibits individual mention, thus they are classified under four broad headings with citation of a few well-known examples.

Archeological sites in the state consist primarily of buffalo jumps, pictographs, and Indian camps. The Department of Fish and Game in 1970 listed 24 sites that were classified as aboriginal-prehistoric (8). Some good examples are the Pictograph Cave near Billings, Madison Buffalo Jump near Logan, and the Hagen Site in Dawson County.

Vestiges of the Indian-white relationship can be found in the form of trading posts, military outposts, missions, and battlegrounds. Montana has more than 90 such sites, a majority of them east of the Rockies (8). Some familiar examples are the Chief Joseph, Custer, and Big Hole Battlefields, Chief Plenty Coups Memorial, St. Mary's Mission, and Fort Benton.

Montana also has about 40 historic mining towns, located principally in the Broad Valley Rockies (8). Good examples include Bannack (Montana's first territorial capitol and now a state monument), Butte, Castle, Helena, and Virginia City. In addition to the mines and equipment, historic buildings of architectural significance are usually associated with the early mining communities.

Numerous other locations of historic interest dealing with such things as art, commerce, religion, transportation, politics, and exploration exist throughout the state. A large percentage are undeveloped and little known to the general public.

In recent years many of Montana's historic, archeological, and paleontological sites have been disturbed to varying degrees by amateur archeologists, bottle hunters, vandals, and developmental activities. A state antiquities act providing for systematic evaluation of the sites by competent personnel would greatly enhance the longevity of this resource. The act should also designate an administrative agency for the sites, establish criteria on which to base the value of a site, and provide for the retention of artifacts in the state.

Fish and wildlife resources

Big game in Montana consists of elk, mule and white-tailed deer, pronghorn antelope, moose, bighorn sheep, Rocky Mountain goat, black and grizzly bear, and mountain lion. Available winter range and habitat changes by man are the primary limiting factors for these species. Because most of the suitable big game range in the state is currently supporting near maximum populations, it is reasonably safe to assume that elk, moose, antelope, bighorn sheep, Rocky Mountain goat, and black bear cannot be significantly increased beyond their present numbers. The grizzly is considered a rare species, but if the encroachment of man into wildlands is controlled, the state can perhaps maintain a huntable population (9). Deer populations, although not as high as they were two decades ago, are now more nearly in balance with their food supply.

Upland game birds are found in nearly all parts of Montana. They include sharp-tailed, sage, blue, Franklin's, and ruffed grouse, ring-necked pheasant, Hungarian and chukar partridge, Merriam's turkey, and white-tailed ptarmigan. The outlook for the forest grouse (blue, Franklin's, ruffed) is generally good since the habitat necessary for their survival will probably continue to be available. Numbers of sharp-tailed and sage grouse will depend upon management of both private and public rangelands, particularly upon specific practices such as livestock usage and, in the case of sage grouse, sagebrush control programs. The decline in the number of pheasants may be a result of intensive agricultural practices, including use of herbicides and insecticides. The outlook for the Hungarian partridge is favorable because of this species' compatibility with farming. Chukar, turkey, and ptarmigan numbers will probably remain variable as a result of climatic and/or range limitations.

Waterfowl in Montana include two species of swans, five species of geese, two species of mergansers, and 23 species of duck (18). The status of waterfowl habitat in Montana is good, thus harvestable surpluses in favorable years may exceed those of recent peak years.

The number of furbearers and predators will be dependent upon fur prices, control programs, and activities affecting habitat. Most predatory animals will probably never become very abundant by virtue of their elevated position on the food pyramid.

Montana has about 1,500 lakes, 15,000 miles of fishable streams, and many hundreds of man-made lakes that support a great variety of fish (18). Cold streams in the western mountains sustain rainbow, cutthroat, brook, brown, and Dolly Varden trout as well as the landlocked sockeye salmon and other game fish. Species occuring in the lower reaches of the Missouri and Yellowstone Rivers and their eastern Montana tributaries include sturgeon, walleye, northern pike, channel catfish, and sauger. Any change in the fish resources will probably be caused by continued human alteration of the aquatic environment. Dewatering, channelization, pollution, introduction of exotics, and in many cases dam building, all have an adverse effect on fish populations.

Conclusions

Modern communication and transportation systems make it impossible to consider the adequacy of Montana's resources without viewing them in light of the national and world situation. The state's remote location, lack of investment capital, and bad climatic reputation can no longer spare Montana's natural resources from accelerated exploitation. Resource depletion in other parts of the country or world will force development of reserves heretofore deemed uneconomical or undesirable. The social and economic goals of the nation will bear directly upon our natural resources and their adequacy for fulfilling human and economic requirements.

Montana's most valuable resource in the future could well be the environmental amenities — clean air, clean water, and the open space and solitude necessary for compatible human existence. As congestion, pollution, and free time increase in the country's metropolitan centers, Montana, particularly Rocky Mountain Montana, will become increasingly attractive for outdoor recreation as well as for retirement and vacation homes. The appeal of this area is already indicated by the growing population and the flurry of real estate activity.

Population distribution (density) could create some problems in the state. Although congestion is not serious at present, it could develop in certain valleys of Rocky Mountain Montana. On the other hand, eastern Montana, according to some viewpoints, may have too few people. The term "social cost of space" was coined to describe the socioeconomic problems of the Great Plains (5). Long distances and low population densities make many services very expensive, of inferior quality, or nonexistent, and social interaction through community organizations is often absent. These problems should be weighed against the "social cost of density," however, before it is concluded that Great Plains Montana would ultimately benefit from increased population. As Athelstan Spilhaus has noted (16):

> When people live scattered and far apart, what they choose to do does not impinge on others, but what they have to choose from is limited. Cities increase the number of choices, but when people overcrowd into too few cities (as they are doing all over the world today), we reach a point of diminishing returns, and choices become more and more restricted once again.

Montana agriculture is faced with the national problem of overproduction. Farmers produce more than can be absorbed by domestic markets, and their products are too expensive to compete on the world market. Consequently, agriculture still depends heavily on government price supports to maintain an acceptable income. Because it is unlikely that the federal government will subsidize exports or contribute substantially to international food programs, increased agricultural demand will stem mainly from United States population growth. In Montana as elsewhere the small family farm will probably continue to decline and the amount of land in cultivation to decrease. Regardless of this short-term trend, the state's most productive agricultural lands should be reserved from competing use to keep long-term options open.

The adequacy of Montana's mineral and energy resources will depend upon how the nation's major resource consumers handle some important decisons. They might continue the present pattern of resource consumption, or they might learn the value of recycling and encourage social and economic patterns that would meet the needs of the people while minimizing per capita use of irreplaceable materials. Foreign relations can also have a direct impact on Montana, since the United States has adequate supplies of only a small number of the important industrial minerals. Reduced foreign supplies might cast a different light on this state's marginal reserves of scarce minerals.

Employment increases in mining and manufacturing depend primarily upon the copper and coal industries. The Montana Economic Study (5) predicts at least three new open-pit operations by 1980, but that expectation in turn rests on the assumption that the market will continue to be as good as it has been in the past. The mining increase may also come in part from utilization of the vast coal reserves in Great Plains Montana. Extensive development of coal could produce thousands of jobs, at least for a few decades, but the timetable for such development is uncertain.

Thermal generation and coal gasification threaten to seriously affect the water supply in eastern Montana by preempting most of the unused surplus. Consumption of up to 75 percent of the available water in the Fort Union Basin by these industries would preclude any further irrigation projects and seriously diminish the recreational value of the Yellowstone River. It also might cut short the domestic supplies needed by accompanying population increases.

Environmental considerations may tend to limit hydroelectric power development. Public opposition is growing to the condemnation of land, installation of transmission lines, relocation of residences, roads, and railways, destruction of wildlife habitat and quality recreation, and other adverse impacts associated with these projects.

Economic growth in the state appears certain, and only through comprehensive planning can orderly growth be accomplished. Population and economic growth will be greatest in Rocky Mountain Montana and, if coal reserves are intensively exploited, in the Fort Union Basin. Coal-based industry could increase the population in the latter area by 300,000 to 400,000 people (1). It is in these two areas that the need for planning is most urgent. Unless growth is anticipated and planned for, development will be the haphazard, boomtown variety, with little thought given to water, sanitation, transportation, communication, political, and other requirements. The apparent abundance of select recreational and residential land in Rocky Mountain Montana is very inviting to speculative land developers. These ventures are often conducted with little foresight or concern for the future and frequently result in degradation of the features that make the area attractive. Large-scale land use planning is necessary to insure that the resources in these two areas and in the remainder of the state will continue to meet human needs on a long-term basis.

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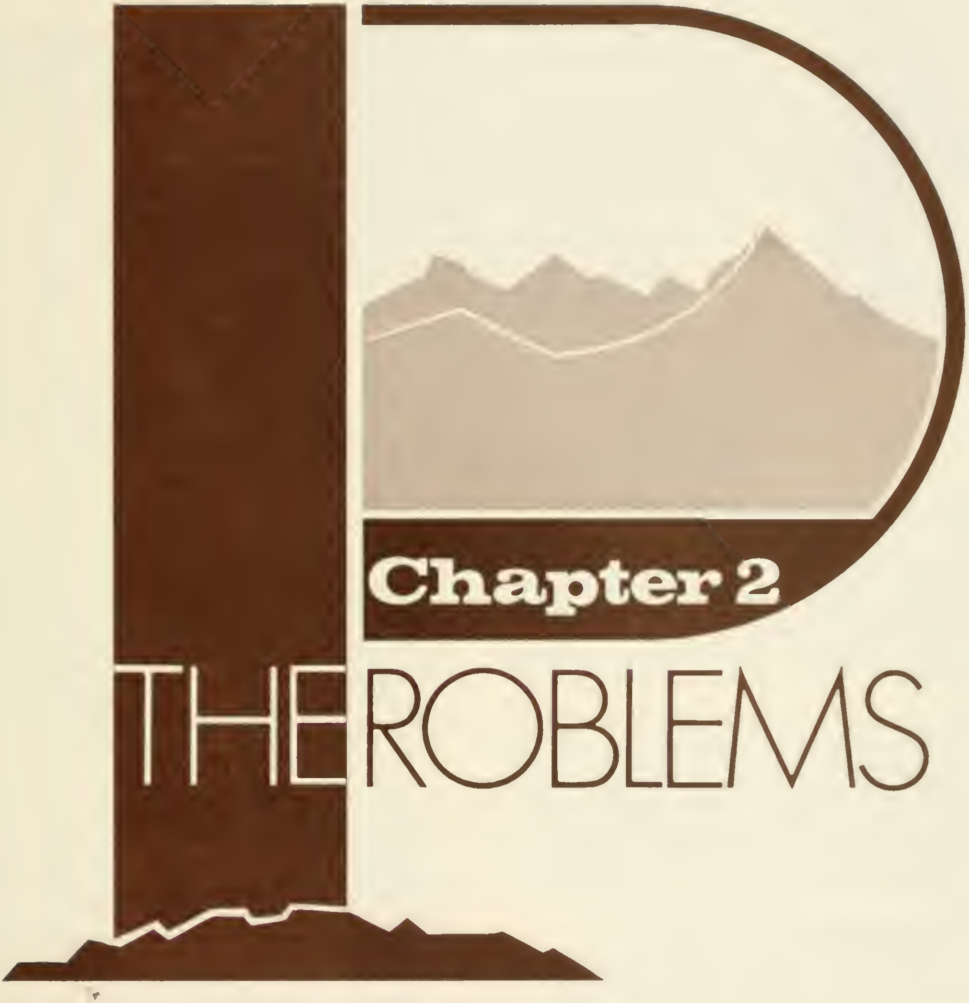


Chapter 2

THE PROBLEMS

Introduction

Montana is a land of diverse environments. It runs the gamut from dry lowlands to icy mountain peaks, from sagebrush rangelands to lichen-draped forests, from booming metropolitan areas to nearly virgin wilderness. The freedom of choice offered by such diversity is surely one of Montana's greatest treasures. In Design with Nature, Ian McHarg puts it this way:

> **Thus the environment, both physical and social, must offer the maximum opportunity for the elaboration of each unique personality. Diversity is seen as an important component of this quest — the provision of the maximum number of opportunities and pathways. As reality consists only in the response to those stimuli impinging upon the individual, then the greater the number and diversity of these, the greater the choice.**

In Chapter I the state was divided into environmental regions, each of which is a unique composite of interrelating environmental factors, and Montana resources were reviewed. This chapter will tell, insofar as possible, what is happening to the environment of each region. Less diverse than the state, a region, with its particular resources, is more amenable to analysis. Even so, large informational gaps will be evident, because precise measurements of environmental conditions and trends are not now consistently available.

Environmental Impact Matrix

The scarcity of quantitative information led us to select a simple method for comparing environmental impacts in the regions of Montana. This graphic aid, the *environmental impact matrix*, was developed by the U. S. Geological Survey for evaluating environmental impact. It can be used for a quick general overview or as a reference checklist.

The matrix arrays human activities (defined in the appendix) against environmental classes (air, water, soil, biota, and aesthetics) to graphically identify significant interactions, especially those that degrade or disrupt environmental quality. A solid dot at the intersection of an activity and a class indicates a major impact; an open circle represents a minor impact. Such a matrix will introduce the material on conditions and trends for each region.

Environmental Perspective

To go beyond the biogeographical descriptions of Dr. Crowley and the simplified approach of the matrix, we have established an *environmental perspective* for each region. In the perspective we will discuss and analyze some of the major impacts noted in the matrix, focusing on environmental amenities and problems.

The problems involve interactions of human populations with complex natural systems (ecosystems). Treatment of environmental problems is usually applied only to the symptoms. In the words of Thoreau, "There are a thousand hacking at the branches of evil to one who is striking at the root." The symptom treatment, in the long run, is inefficient and expensive — biologically, economically, and socially. Basic solutions can best be developed by viewing problems in context with the whole environment — its totality of air, water, land, and living things. Man does not completely understand the interaction of the environmental components, which operate through biological, chemical, and physical cycles to form the whole. It is known, however, that modification of one component can disrupt the entire system.

Retention of many relatively intact ecosystems gives Montana its environmental amenities and the intrinsic strength of its life support systems. This does not imply that we should not use our environment to attain human goals. It does mean that use of the environment to achieve short-range goals must be within the long-range framework of perpetuating the integrity of Montana's ecosystems. Beneficial resource management is based on this principle and requires understanding of ecosystem functions and capabilities. The term exploitation, with reference to the environment, means that resources or amenities are used beyond the capacity of the ecosystems to sustain such use without degradation or depletion.

Interlocking combinations of ecosystems vary from region to region, producing different kinds of life support systems. Diversity in these systems in turn produces diversity in human activity. Obviously the prairies of the Big Dry region do not support a logging industry and the forests of the Columbia Rockies do not contain a major range resource. Thus the capabilities of the life support system in a region limit the kinds of land use. Usually several alternatives exist in one given space, and competing uses for that space lead to tradeoffs. If the capabilities of the space have been identified and allocation of resources is properly planned, the coexisting uses can be compatible, with minimal ecosystem disruption. On the other hand, unplanned, uncontrolled use or development almost inevitably causes environmental degradation.

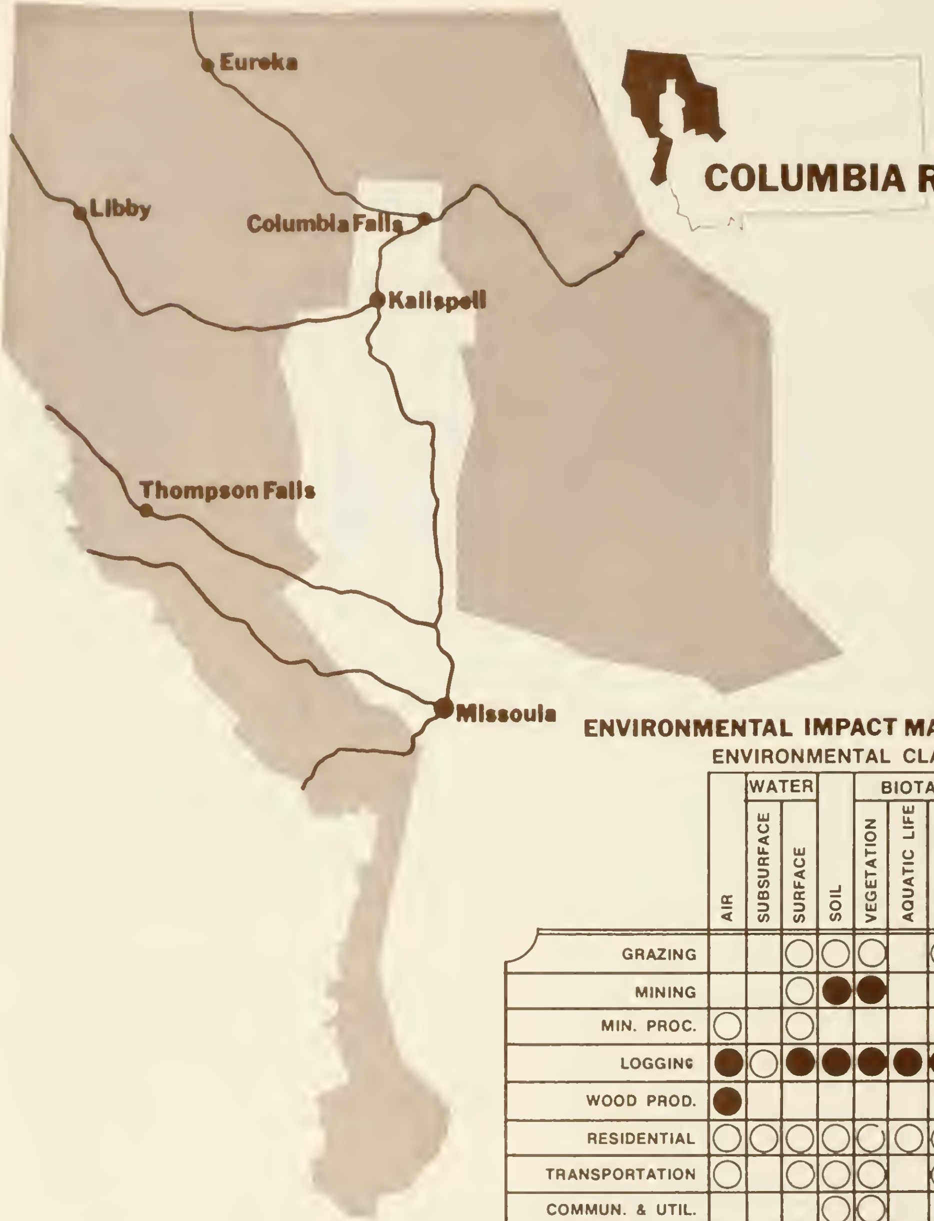
Degradation, maintenance, or enhancement of environmental quality is difficult to evaluate, in some cases, without quantitative measurements at regular time-intervals — the process called monitoring. A survey of the status of monitoring efforts in Montana has revealed a lack of coherent, systematic programs that can tell definitely whether environmental conditions are getting better or worse. (This is especially true of Great Plains Montana.) We found that some agencies with environmental responsibilities could not now answer this "better or worse" question and that most were not funded or staffed to carry out comprehensive monitoring. Improved coordination and expansion of existing efforts is clearly needed, including measurement of various parameters not now monitored.

In this chapter, available *environmental quality indicators* have been used as a quantitative aid in developing the perspective for each region. These indicators, such as air and water quality and game range ratings, reflect the present condition of some of Montana's environmental components and are considered baseline; those of subsequent years will indicate degradation, enhancement, or stability relative to current levels. We limited our selection of indicators largely to parameters that can be measured quantitatively. These indicators must also unquestionably reflect a change in environmental quality and must be measurable at appropriate time-intervals.

Contributed Papers

In some instances this chapter's regional coverage includes *contributed papers* that expand our analysis of environmental conditions and trends and pinpoint problem areas, including land use conflicts. For example, the matrices for all regions of Rocky Mountain Montana show major impacts from logging. The paper contributed by the University of Montana School of Forestry treats this topic by reviewing management and forest ecosystems in the Rocky Mountains. Another example is Mr. Robert Anderson's paper on the Absaroka-Beartooth area of the Yellowstone Rockies, where mining, including exploration, is a major impact.

COLUMBIA ROCKIES



ENVIRONMENTAL IMPACT MATRIX

ENVIRONMENTAL CLASSES

		WATER			BIOTA			
	AIR	SUBSURFACE	SURFACE	SOIL	VEGETATION	AQUATIC LIFE	WILDLIFE	ESTHETICS
GRAZING			○	○	○		○	
MINING			○	●	●			●
MIN. PROC.	○		○					
LOGGING	●	○	●	●	●	●	●	●
WOOD PROD.	●							○
RESIDENTIAL	○	○	○	○	○	○	○	○
TRANSPORTATION	○		○	○	○		○	○
COMMUN. & UTIL.				○	○			●
WATER STORAGE	○	○	●	●	●	●	●	●
RECREATION			○	●	●	○	○	●

○ MINOR
● MAJOR

Columbia rockies

Environmental Perspective

Wilderness environments are a benchmark for modern man. Here ecosystems that evolved through millions of years continue endless flows of energy and cycles of matter. Here space-age man finds escape from the "future shock" his artificial systems and monocultures have created. "For me, and for thousands with similar inclinations," Bob Marshall wrote,

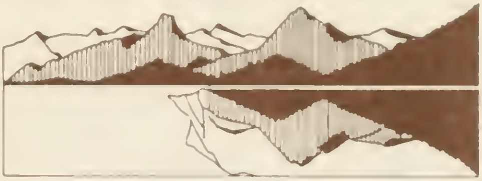
> **. . . the most important passion of life is the over-powering desire to escape periodically from the clutches of a mechanistic civilization. To us the enjoyment of solitude, complete independence, and the beauty of undefiled panoramas is absolutely essential to happiness.**

The Columbia Rockies region contains five separate units of designated wild and primitive land: Bob Marshall Wilderness (950,000 acres), Scapegoat Wilderness (233,000 acres), Cabinet Mountains Wilderness (94,272 acres), eastern portion of Selway-Bitterroot Wilderness (291,085 acres), and Mission Mountains Primitive Area (73,340 acres). It also contains a great volume of other roadless land, 684,000 acres of which may be recommended for inclusion in the wilderness candidate study program, for a current total of more than two-and-a-third million acres of designated or potential wilderness.

In the wildlands listed above, in Glacier National Park, and in other undeveloped areas, the Columbia Rockies provides environments capable of fulfilling the spiritual and psychological needs described by Bob Marshall.

The mountains and valleys of the Columbia Rockies also provide for more material human needs through abundant, high-quality timber and water and desirable land for residential and recreational development. Thus, even though the estimated population density is less than two persons per square mile, and over 70 percent of the region is in public ownership, it is not surprising that the most significant ecosystem disruptions have resulted from logging and wood products manufacturing, multipurpose water storage projects, recreation, and mining, with less profound but important impacts from other developmental pressures.

Monitoring of environmental parameters is fairly recent in this region, and information is spotty. Available indicators of air and water quality are supplemented, however, by other data relating to the adequacy of the Columbia Rockies' physical and biological systems to sustain development of its resources without impairment.



Activities shown on the matrix are often interrelated in terms of their environmental impact; one of the less significant in this region — grazing — is not discussed in detail here, though it contributes to the interacting effect of human activities on the natural environment.

The Columbia Rockies' open-space resource, including wilderness, is outstanding in both size and quality. Over the years its components have been affected, in varying degrees, by natural and man-made disturbance. As described by Dr. Crowley in Chapter 1, erosional landforms from glaciation dominate this region. In the high mountain wilderness and elsewhere, cirques, U-shaped valleys, trough lakes, hanging valleys, and lateral and terminal moraines are characteristic landscape features. Deep glacial till contributes to unstable soils subject to slides and other forms of geologic erosion. The 1964 floods along the Continental Divide seriously altered stream channels and banks. Water quality is generally excellent except for sediment loads from spring runoff, storms, or geologic happenings. Low nutrient levels produce fragile aquatic ecosystems with only a few species of fish. One, the native west-slope cutthroat, is endangered. Even in wilderness, exotic species such as brook trout, rainbow, and yellowstone cutthroat have been introduced, sometimes to the detriment of native species.

A reflection of the ecological diversity of the open-space areas of the Columbia Rockies is in the continued existence of nearly all forms of native fauna. Mule and white-tailed deer, elk, moose, mountain goat, mountain sheep, mountain lion, Canada lynx, bobcat, black and grizzly bear, wolverine, marten, fisher, otter, coyote, and wolf still inhabit the region. Among the large mammals only the mountain caribou is gone, although the wolf is endangered. Diversity is also maintained among the birds. The magnificent trumpeter swan no longer breeds in the Columbia Rockies but may appear as a transient. Four consecutive years of survey data on breeding birds for a route south of Alberton show a four-year average of 47 species in this part of the region with a high in 1971 of 51 species.

The Department of Fish and Game administers 1,098 acres of game range in two game management areas —

Alberton and Bowser Lake — in the Columbia Rockies. The department's deer, elk, and bear season recommendations for 1972 report deer and elk range conditions on the hunting districts in the region as mostly fair to good, with several rated as poor to very poor and only one as very good. The lower ratings may be due to reforestation after the 1910 fire and other early burns and subsequent decline of preferred big game forage.

The region's abundance of open-space amenities is reflected in its volume of outdoor recreation sites: the Forest Service maintains a total of 68 campgrounds and 10 picnic grounds in the Columbia Rockies; the Fish and Game Commission controls 25 acres at 11 fishing access sites and administers six state parks and recreation areas totaling 390 acres. About 10 miles of the Class 1 "blue ribbon" waters of the Flathead River lie within the region, plus 387 miles of Class 2 waters and hundreds of miles of lesser-class fishing streams.

Human density and heavy use have had various environmental consequences at some of the most popular recreation developments, particularly those associated with lakes not far from Glacier Park. Such impacts will be discussed in context with residential development and transportation.

Even within the protected wilderness of the Columbia Rockies, environmental quality has been degraded in some places by recreational overuse — many main trails and campsite areas in the Bob Marshall and Selway-Bitterroot are badly deteriorated in terms of soil and vegetation. In other cases, wilderness quality has suffered from the disruption of open space along its borders. For example, roading and logging to wilderness boundaries in national forestland contiguous to the Bob Marshall and the Cabinet Mountains have adversely affected intangible values of the wilderness itself, and may threaten some of the tangible components as well. Precise quantitative information is largely unavailable in such cases, nor, philosophically speaking, is it necessary. The true boundaries of wilderness are ecological, not geographical; the wilderness resource is in the human mind and heart as well as on the land. Further invasion of hitherto undeveloped open space in the Columbia Rockies, whether near wilderness boundaries or not, whether by timber, water, recreational, residential, or other projects, should be carefully considered in terms of the region's overall open-space resource, including the current and potential economic value of maintaining "the beauty of undefiled panoramas."

Meanwhile, in the high country of the Columbia Rockies, the winds blow clean and fresh, bearing only ubiquitous global pollutants or, at times, smoke from distant slash fires and powderfine dust from thousands of horse-days on the trail. Waters flow sparkling and clear, enlivened by brilliant falls, rapids, and cascades and, in some places, the reflection from a beer can. Man and his creatures have left their mark. The fabric is torn but not yet raveled. The cyclic systems continue, but the term "pristine" becomes less fitting each year.

Forest ecosystems, producing timber, water, range, wildlife habitat, and recreation resources, are the major economic base of the Columbia Rockies. Deep coniferous forests clothe the land shaped by glacial forces. Trees are a dominant environmental feature from valley grassland to alpine tundra. Noncommercial and inoperable timberlands comprise much open space in addition to wilderness, but on more productive and accessible sites mature coniferous forests become sawtimber, the land is managed to satisfy material human needs, and problems of environmental disruption and pollution from logging and wood products manufacturing occur.

The Kootenai and Flathead National Forests, which lie almost entirely within the region, contain 1,587,300 acres and 1,162,200 acres respectively of forestland classified as commercial. Within the last six years 50,832 acres of the Kootenai have been harvested by the clearcut method and 44,083 acres by other methods. Corresponding figures for the Flathead are 33,500 and 21,790 acres.

The effects of timber harvest on forest ecosystems — in terms of soil, water, wildlife, and related values — are discussed in the following paper contributed by the University of Montana School of Forestry. Environmental problems caused by the wood products industry do not stop with removal of the logs from the forest, however, although the primary impact of industry activities shifts its focus from land and water to air.

Post-harvest slash burning is a significant seasonal source of air pollution. During 1971 slash was burned on the Kootenai and Flathead National Forests for a combined total of 80 days. Considerable slash burning also took place on the portions of five other national forests that lie within the Columbia Rockies. A recent report on air pollution problems at Libby (8) commented that ". . . slash burning in the area envelops the entire valley in smoke during the fall months."

Year-round problems derive from wood products manufacturing, especially if the mill is located in one of the many inversion basins of western Montana. Libby is a prime example; strong inversions are frequent here, and winds are very light. The nearly total stability of the valley air intensifies pollution from the combustion practices of the local lumber industry, from heavy traffic on 20 miles of dusty, unpaved streets, from open burning of trash, and, seasonally, from slash burning. As a result of such concentrated contributions from multiple sources, in terms of suspended particulate and smoke in the air, Libby is dirtier than Chicago, Cincinnati, Los Angeles, New York City, or Portland (8).

During 1969-1970 the average total suspended particulate load in Libby, at a station considered most descriptive of air quality in the community, was 243 micrograms per cubic meter of air, the highest mean level ever recorded in Montana (8). This was an increase of 47 percent over the 1961-1962 average. The maximum permissible concentration of suspended particulate (annual mean) in Montana is 60 micrograms per cubic meter of air.

Dustfall at the same station in roughly the same 1969-1970 period was consistently above the state standard. This was attributed primarily to the town's dirty streets combined, possibly, with the rise in vehicular traffic associated with the building of Libby Dam. Although the increase in Lincoln County population, a large portion of which resides in Libby, was 44 percent from 1960 to 1970, the increase in motor vehicles during the same period was 88 percent. Other wood products centers in the Columbia Rockies have similar but less severe air quality problems.

Recent information indicates that a number of tepee burners in the region are not in compliance with state air quality regulations (7). Other air pollution sources, unrelated to the forest products industry, that are not in compliance include uncontrolled open burning in seven communities, five cases of improper incinerators, a vermiculite plant, and lack of adequate dust control. As of December 31, 1971, not one community in the Columbia Rockies had a properly managed landfill disposal site, although landfill conversions were proposed for Alberton, Libby, and Superior by July 1, 1972. The Eureka and Seeley Lake disposal sites have no burning but infrequent covering.

Although mineral processing is not a source of significant environmental impact within the region, the Anaconda Company aluminum plant at Columbia Falls in the adjacent Broad Valley Rockies emits about 2,500 pounds of fluoride per day, some of which is carried by prevailing winds over a wide area of the Columbia Rockies. Preliminary investigations by the Department of Health and Environmental Sciences revealed that the state ambient air quality standard was exceeded in seven of 14 monthly air samples taken in Glacier Park in 1969-1970 (8).

A 1971 Forest Service report (2) showed that vegetation in 71,670 acres of Glacier National Park had accumulated fluoride in quantities greater than 10 parts per million. Plants were lightly injured on 9,600 acres and moderately injured on 371 acres, showing average accumulations up to 60 parts per million in pines and Douglas-fir. If emissions are not reduced to the state standard, the report concludes, "Forest vegetation would continue to decline, and the southwestern portion of Glacier National Park would continue to sustain a chronic level of injury caused by excessive fluorides."

Mineral exploration and development have been intense within established mining districts. Elsewhere, the region's lower-grade peripheral deposits are largely untapped. Rapidly accelerating exploratory activities, including overburden removal and drilling operations, are nonetheless a basis for listing mining as a major impact on the region's soil, vegetation, and esthetic resources. Such mineral exploration often occurs in and immediately adjacent to wilderness areas (Cabinet Mountains and Scapegoat) and severely damages natural ecosystems.

Human activities associated with residential development produce a variety of significant interactions with environments. In 1971 the Columbia Rockies had a greater percentage of its population (20 percent) served by unsatisfactory public drinking water supplies than any of the other six environmental regions in Montana. According to health department statistics, the supplies contaminated were those for Libby-Pinewood, Fortine, Summit, Trout Creek, Thompson Falls, and Troy, communities totaling 2,882 people.

The impact of municipal waste discharges on water quality is relatively small because the region contains only two percent of the state's sewered population. Forty-two percent of the Columbia Rockies' sewered population is served by secondary treatment (lagoons and trickling filters) and 58 percent by primary treatment, consisting of mechanical clarification at Libby and Eureka. These two plants are expected to be in compliance with secondary treatment requirements by 1977.

Nevertheless, water quality in Lincoln County is generally poor. The Environmental Protection Agency cited the area as one of 10 in Montana with severe water quality problems. This assessment was made by use of a "pollution priority index," which identifies water pollution zones based on the section of stream affected and the duration and intensity of the problem.

The Kootenai and Flathead National Forests are currently monitoring water quality — a number of chemical and physical constituents as well as coliforms — at 20 stations in the Columbia Rockies. Several other forests in the region are monitoring water quality in cooperation with the U. S. Geological Survey, Soil Conservation Service, and state agencies.

The Lolo National Forest has been working with the University of Montana in studying the eutrophication of Seeley Lake, one of Montana's most popular recreational lakes. A recent graduate thesis on the subject reported Seeley Lake as moderately eutrophic (3). Nutrient enrichment was attributed primarily to the building of a dam and subsequent flooding of 300 acres above the lake for the past 20 years. Other nutrient sources contributing to the problem were clearcutting in the drainage basin, the high number of people using the lake for recreation and cabin sites, domestic animals grazing on land above the lake, artificial fertilizer applied to hay meadows above the lake, and septic tank leakage and overflow.

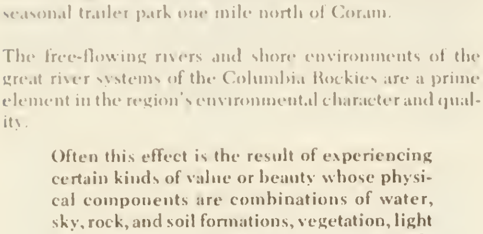
The Columbia Rockies is undergoing accelerated development of subdivisions for recreational or second homes. Since April, 1972 the Department of Health and Environmental Sciences has filed environmental impact statements regarding removal of sanitary restrictions from four subdivisions located near Yaak, Thompson Falls, and Salmon Lake. Lands involved are usually not agriculturally productive, and because extensive public lands are available, recreational opportunities are as yet not seriously curtailed. Exceptions could involve access to some lakes ringed by private development if provisions for the public are not programmed into the projects. Current trends in subdividing emphasize the need for improved laws and regulations as well as for adequate planning

The presence of a major tourist destination, Glacier National Park, combined with the excellent environmental amenities of the Columbia Rockies, causes significant impact upon those areas nearest to components of the transportation system. These pressures, coupled with the policy of the National Park Service to discourage development of additional overnight facilities within the park, have accelerated land use tradeoffs toward establishment of more commercial campgrounds and trailer courts along the transportation system. The health department has recently submitted an environmental impact statement concerning removal of sanitary restrictions at an 89-unit seasonal trailer park one mile north of Coram.

The free-flowing rivers and shore environments of the great river systems of the Columbia Rockies are a prime element in the region's environmental character and quality.

> **Often this effect is the result of experiencing certain kinds of value or beauty whose physical components are combinations of water, sky, rock, and soil formations, vegetation, light patterns, and effects of the elements. Wildlife variety and abundance are considered a part of the environmental effect (4).**

With headwaters or important tributaries of three major drainages — Columbia, Missouri, and Hudson Bay — in the region, it is to be expected that some rivers, such as the Kootenai and Clark Fork, are already converted to engineered ecosystems and that plans exist for the conversion of others.



Water storage projects have produced major environmental impacts on the Columbia Rockies, from previous construction of Noxon Rapids, Hungry Horse, and Cabinet Gorge, and from current construction of Libby Dam. These impacts must be viewed in context with the overall effects of multipurpose impoundments in the region, past, present, and future. The issue of water storage and hydroelectric power generation is of such importance in the Columbia Rockies that it merits some general background discussion:

Hydroelectric energy derived from falling water is a form of stored solar energy. Water is carried to high elevations in the course of the normal hydrologic cycle powered by the sun. Hydroelectric dams are at present the only successful method of concentrating diffuse solar energy into a usable supply of electric power on a large scale without burning fossil fuels. Hydropower has advantages over other forms of electric generation in that no fuel is required and, theoretically, the process is available as long as the sun and the oceans exist. In practical application, however, the hydropower supply is limited by the scarcity of suitable sites and by the relatively short life of impoundments, usually 100 years or less. The problem of what to do with obsolete sediment-filled reservoirs is yet to be solved.

Hydroelectricity is cheap only because the planning of proposed dams and reservoirs disregards a development's consequences for human systems and natural ecosystems. And yet, as one author put it,

> **Few actions of which man is capable in a similar time and place can have such far-reaching ecological effects — physically, biologically or socioeconomically — as a major hydroelectric dam (5).**

The magnitude and variety of impacts upon the human environment suggested by this statement lead to the logical conclusion that planning to avoid or mitigate these impacts should be of similar magnitude. Instead, available evidence indicates that planning and cost-benefit analyses are preponderantly concerned with technological and short-range economic factors and that social and environmental assessments, if any, play a secondary role (1).

One of the widely recognized environmental effects of reservoir construction in many regions of the world is an increase in the frequency and intensity of earthquakes. The seismicity of a dam and reservoir site depends primarily on the structural geology of the site; a complex area containing an intricate system of faults and fractures is more susceptible to induced seismic activity. Crustal loading beneath the reservoir, along with lubrication of faults through hydrostatic injection, can upset the geologic equilibrium and cause movement along previously inactive faults. Recognizing such potential environmental effects, the Earth Sciences Laboratories of the National Oceanic and Atmospheric Administration have recommended that

> **. . . a seismograph station be installed in areas of large man-made lakes, dams, and reservoirs at the time the site is proposed to provide a history of seismicity prior to construction.**
>
> **If the area is seismically active additional stations should be deployed to locate the earthquake hypocenters and if possible to determine the earthquake mechanisms in addition to frequency of occurrence, characteristics and magnitudes. Close coordination should be maintained with the project geologist; if the earthquakes can be considered associated with surface faulting there should be monitoring networks of stations across the fault to determine if there is movement (6).**

In spite of the fact that western Montana is recognized as an area of moderate to extreme earthquake risk, its dams have not received this kind of preconstruction seismic investigation. The Environmental Quality Council, through a formal resolution, has recommended to all agencies and enterprises likely to build dams in western Montana that adequate seismic investigation precede construction (see Chapter V).

Reservoir impoundments can also increase the possibility of mass-gravity movement, especially in valleys characterized by glacial oversteepening or inactive landslides. Potential for this hazard has been identified at Libby Dam, where inactive landslides have been extensively instrumented with early-warning systems. One small slide has already been triggered by construction disturbance at the damsite.

Alteration of the hydrologic system above and below Libby Dam is obviously a major environmental impact. The reservoir is changing from a riverine ecosystem to a lake ecosystem — from an erosional system to a settling basin. Ponding causes temperature stratification within a reservoir, alteration of the downstream water temperature, and reduction of diurnal temperature fluctuations in both. Rates of evaporation and groundwater recharge in the basin are increased.

Changes in the aquatic ecosystem above the dam differ from those downstream. Nutrients derived from drowned plants, animals, and organic soil components are released suddenly as the reservoir fills. This biogeochemical enrichment stimulates rapid growth of indigenous periphyton and phytoplankton. Growth of these primary food producers is reflected up the food chains, most of them leading to fish. Decomposition of the initial nutrients and the resultant algal blooms place an elevated oxygen demand on the system. Consequently, poorly circulated portions of the reservoir become stagnant, devoid of oxygen, and laden with hydrogen sulfide. These conditions can be reflected downstream depending on the level of the penstocks, the aeration received during release, and the downstream gradient. Installation of a selective withdrawal or multi-gated system in Libby Dam may possibly help to reduce the environmental impact of some of these conditions. Meanwhile, as the reservoir fills and the current decreases, as flowing-water habitat disappears and quite-water habitat expands, current-dependent organisms decline while quiet-water species become dominant.

Effects on downstream aquatic life are sometimes drastic. Dams serve as barriers for migratory fish. (Fish passes have been included in many dams, but such devices are far from universally successful.) If fish migrating downstream are forced to pass through the turbines, a high rate of mortality is inevitable. Passage of water through the spillway into a deep stilling basin below often results in nitrogen supersaturation, which at Libby Dam has recently killed thousands of fish for several miles downstream. Also, stabilization of the river flow may disrupt reproductive habits of floodwater spawners. The survival rate is lowered by the elimination of nutrient-rich floodwater areas serving as nursery grounds for the young. Sedentary and attached organisms are favored by the stabilized flows.

Hydropower is sometimes referred to as a nonpolluting method of generating electricity. Air quality problems are usually minimal, although blowing dust from exposed mud flats can be troublesome. (A notable example of this for over a decade has been the dust problem at Townsend from Canyon Ferry Reservoir in the Broad Valley Flats. The Bureau of Reclamation agreed last year to install dikes and maintain water levels in the mudflat area and this project is now under construction. The Montana Department of Fish and Game will manage the new aquatic habitat as a waterfowl area.) In the Libby vicinity the Army Corps of Engineers is (and during 1972 and 1973 will continue to be) in violation of state open burning regulations for its site-clearing and reservoir drift disposal activities associated with the project (7). As noted, water quality problems that may occur include hydrogen sulfide and nitrogen supersaturation and excessive algal blooms from nutrient enrichment. These factors and others may cause taste, odor, and color problems. Whether or not they are considered pollution, they kill fish, degrade water quality, and disrupt aquatic ecosystems.

Human environments are affected directly and indirectly by water storage projects. In addition to altering water quality, and sometimes air quality, filling the reservoir inundates homes, businesses, transportation networks, and communication systems. Major construction projects often place a severe economic, social, and esthetic burden on local communities. Libby Dam is again a prime example: the influx of large numbers of people into Libby and Lincoln County during the construction phase have required temporary housing and created a swollen demand for services and educational facilities. At Libby and elsewhere this has led to a complex of cheap, impermanent structures incompatible with the local environment and to a strain on city and county funds.

Inundation destroys fish and wildlife habitat. In the case of Libby Dam, the lower reaches of several tributaries to the Kootenai River — important spawning areas — will be covered by Lake Koocanusa. Twelve thousand acres of important big game winter range along the east side of the Kootenai will also be inundated.

Relocations associated with dam construction can be socially, ecologically, and esthetically destructive. Relocation of the human population of the impoundment basin can cause serious disruption of human systems — uncertainty stems from loss of the familiar and imposition of the unfamiliar. Filling Lake Koocanusa has necessitated moving the town of Rexford. Relocation of a Forest Service road and State Highway 37 will further reduce available wildlife habitat and hamper wildlife movements. Relocation of the Burlington Northern mainline has caused an additional loss of wildlife habitat and has shortened the channels of Wolf Creek, Fortine Creek, and the Fisher River by about two miles. Both ecological impacts and psychological pressures can be minimized to an extent if state conservation agencies, local governments, and individuals directly affected are given a voice in decisions concerning the how and where of relocation.

Multipurpose dams can generate other associated developments with environmental ramifications, including power transmission lines, new industry attracted by large amounts of cheap electricity (such as the aluminum plant at Columbia Falls using power from Hungry Horse Dam), industry attracted by increased availability of water (such as the proposed steam electric generation plant at Eureka), or mass recreation developments on the reservoir itself.

Human and environmental losses from multipurpose dam projects should be considered in the framework of these projects' contribution to total energy production. In the United States, the fraction of total energy produced by oil and natural gas increased from 7.9 percent to 67.9 percent between 1900 and 1965, whereas

> **Water power, although continually increasing in magnitude, (has) maintained a nearly constant percentage of total energy produced. It increased only from 3.2 percent in 1900 to 4.1 percent in 1965 (9).**

Although hydroelectric power generation cannot be expected to add significantly to the nation's long-range energy supplies, it can, in the Columbia Rockies and elsewhere, diminish or destroy the long-range value of natural river systems. For this reason, it is vitally important that the ecological integrity of some of the Columbia Rockies rivers be protected through state and federal legislation. Part of the South Fork of the Flathead is protected because it flows through the Bob Marshall Wilderness. For some others, wilderness classification is not the only, or even a workable, alternative. In these cases, designation as a protected free-flowing river would not only preserve natural values but allow many kinds of ecologically compatible developments.

In sum, the activities producing major impacts on the Columbia Rockies environment can probably not be sustained at a much heavier level than the present without permanent degradation of the amenities and resources that have led to such activities. The mountains are blemished by mining and recreation, the forests are scarred by logging; the rivers are choked by impoundment. The magnificent fabric is indeed torn — and could be at the point where it will ravel. The Columbia Rockies is perhaps a microcosm of what is meant by "our natural heritage" of wilderness and open space. Like most inheritances, it can easily be squandered.

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MANAGEMENT AND FOREST ECOSYSTEMS

Contributed by
School of Forestry
Montana Forest and Conservation
Experiment Station
University of Montana*

Introduction

Forest management is a controversial subject, in Montana and elsewhere. Our forests are the source of numerous goods and amenities that are shared by people with different land use philosophies and goals. We believe that Montanans and others throughout the nation have the right to enjoy a high-quality forest environment and that this will not be possible without skillful, flexible, and sensitive management.

A high-quality human environment must satisfy three basic criteria. It must be healthy, providing clean air and water. It must allow the security of adequate food and shelter. It must, finally, be enjoyable, offering attractive surroundings and diversified opportunities for relaxation, stimulation, and psychic renewal. The forest ecosystems of Montana can furnish many elements of such an environment.

The term forest ecosystem is used to express the interrelated characteristics of forested land – its structures, functions, patterns, and processes. It is also used to describe identifiable forest units that differ from surrounding units. An ecosystem is a basic unit of nature, an arbitrarily sized complex of ". . . organisms and their nonliving environment, each interacting with the other and influenceing each other's properties, and both necessary for the maintenance and development of the ecosystem" (5). A forest ecosystem is specifically one in which trees are the dominant vegetation. Any discussion of the effects of management on forest ecosystems must consider the forest community as an entity changing in time and space. Changes occur in the absence of man; they occur much more rapidly and drastically in his presence.

Forest management has been defined as the practical application of scientific, economic, and social practices to the administration and working of a forest estate for specified objectives (10). Implicit in this formal definition are two ideas that should be emphasized: First, forest management encompasses many fields of knowledge, ranging from basic ecology through timber marketing to the social implications of land management decisions. Second, the "specified objectives" of forest management are often combined in the term multiple use. Management must attempt to integrate the many values and frequently incompatible uses of the same forest.

This paper will primarily discuss timber management, the focus of current controversy, and will briefly review its known effects on Montana's forest ecosystems. The varied values of forests, and the desires of people to both "preserve" and "create" a Montana environment, cause management to range in intensity from nearly no disruption of natural forests to the extreme disruption of large areas. Also, different forest ecosystems react differently to any

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particular degree and type of management practice. Mistakes in managing Montana forests have often been the result of inadequate ecological information or of not applying information that is available. In the former case, Montana's lack is shared by other parts of the nation. Leaders in government, industry, and institutions are becoming aware of the dearth of holistic studies concerning ecological impacts of forest management, and we are hopeful that this situation will be rectified soon.

Montana's Forests

Forests cover 21,648,000 acres of Montana. About 17,300,000 acres are classified as commercial and the remainder are in national parks, wilderness, or low-producing sites on steep slopes or arid lands.

Forestlands provide timber, water, wildlife, recreation, livestock forage, and many less tangible values. The state's primary export product from its forests has been timber. Montana's estimated 55,770,000,000 board feet represent about 24 percent of the total timber volume in the eight Rocky Mountain states.

Most of Montana's commercial timberlands are in the western mountains and are publicly owned and managed. Except for acreage in the original railroad grants, private holdings are mostly confined to the valley bottoms. The ratio of public to private forestland is approximately four to one.

The Nature of Forest Disturbance

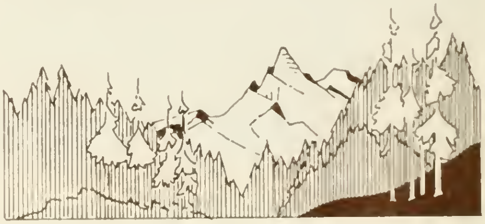
Natural disturbance plays a major ecological role in the dynamics of forest ecosystems. Change, sometimes gradual and sometimes abrupt, is normal. Many factors including wind, fire, disease, insects, and vertebrate animals (see wildlife section) affect natural regeneration processes, genetic selection, and plant succession, and are in turn affected by the alterations they have caused.

Wind

Wind often creates a sudden and dramatic disturbance. The magnitude of the effect depends on wind intensity, the particular tree species involved, and the physiographic features of the site. In Montana, western larch is the most windfirm species and Engelmann spruce the least. Wind effects may vary from blowdown of the individual tree to the leveling of large stands. Physiographic features that tunnel the wind or that increase the density and pressure of air currents heighten the potential for drastic disturbance (1). Natural stands that develop within these wind patterns are able to survive for long periods; however, changes in stand structure, whether by natural factors or harvest, may increase the probability of windthrow damage. Wind disturbance often initiates natural regeneration by opening the stand, permitting more light to enter, and exposing mineral soil where trees are uprooted. At the same time, blowdown material creates insect and fire hazards by adding to the accumulation of debris.

Fire

Fire has played a major role in shaping Montana's forests. Daubenmire (8) ranks it as equal in importance to soil, water, temperature, and other fundamental ecological factors that influence plant succession. The effect of fire on stand composition suggests possible management uses in western Montana (15, 16).



Numerous Montana tree species such as western larch, Engelmann spruce, and lodgepole, ponderosa, and western white pine, which would otherwise have been replaced by climax species, have been perpetuated by the repeated incidence of fire. Their regeneration habits are adapted to fire-created conditions. For example, the thick basal bark of western larch protects mature trees against the heat of the fire. The seed cast by surviving trees falls on a favorable bed of fire-exposed mineral soil, often giving rise to overly dense stands of young trees. Another example of fire adaptation is found in the cone serotiny (or closed-cone habit) of lodgepole pine. These serotinous cones survive in the crowns of burned trees and open to release seeds over the fire-prepared seedbed, a process similar to that for larch. Young "dog-hair" stands of lodgepole pine originate in this manner.

Although single burns tend to maintain tree cover, fires do not always favor forest perpetuation. Repeated burns on steep south slopes on granitic soils have caused accelerated erosion and critical soil loss (35). Also, repeated burns at short intervals, especially on south-facing slopes, may change the plant community from one dominated by trees to one dominated by shrubs. Extensive areas in Montana and Idaho have thus been converted by multiple burns, and much time is required before trees successfully reinvade such areas. Repeated burns are less frequent since the advent of organized fire protection, but because of the long recovery time their effects are still visible on the slopes of the Rockies.

Light, repeated groundfires in the more mature stands of ponderosa pine have a thinning effect (33). Such fires produce the clean, picturesque, park-like stands that were so prevalent before fire protection. These light fires reduce the accumulation of debris and limit the growth of succeeding species such as Douglas-fir and grand fir. Because fire protection has greatly reduced the frequency of light burns, climax species are now flourishing in the understories of many seral stands.

Insects and Disease

Insect infestations are another ecological force that greatly influences the composition, structure, and succession of Rocky Mountain forests (23). Large numbers of trees killed by insects may hasten succession by eliminating the overstory and releasing understory species. Insect-killed trees may also increase the intensity of wildfire, which, as described above, can set back succession by establishing another seral stand (32). An example is the 28,000-acre Sleeping Child fire of 1961, in which stands previously infected by mountain pine beetle burned out of control. Heavy natural restocking with lodgepole pine after the fire required thinning of 15,000 acres to achieve good growth rates and avoid stagnation.

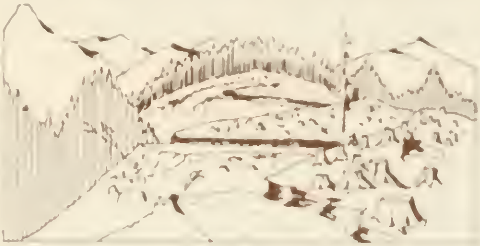
Many mature and overmature stands are decimated by disease-causing organisms such as dwarfmistletoe, rust, and needle-blighting and canker-forming fungi. All of these diseases affect Montana forests to some degree. Mistletoe infection is a major problem. It occurs in all Montana species, with the exception of ponderosa pine, growing east of the Bitterroot Mountains. Seral species such as larch and lodgepole pine appear to be especially vulnerable to dwarfmistletoes. Douglas-fir, a climax species in some ecosystems, is also highly vulnerable (19). Heavy infection not only slows growth but causes mortality, dead trees and witches'-brooms (overgrowth) contribute to forest litter and fire hazard.

In lodgepole pine the intensity of dwarfmistletoe infection increases in proportion to the age of the stand. Here the death of host trees and the intervention of wildfire has a sanitizing effect, although isolated trees or groups of trees that escape the fire often serve as a nucleus for reinfection.

Management Practices

How closely do forest management practices mimic the natural disturbances discussed above? Some practices are designed to replicate natural processes and may have little impact on the forest ecosystem, while others are inimical to the ecosystem and inhibit its ability to recover. A real problem in forest management is determining the amount of disturbance the ecosystems can sustain from fire control, road construction, and silvicultural (including logging) practices without suffering irreversible damage.

Fire control has been aimed primarily at protecting the economic value of standing trees as well as life and property. Because fire has been a major natural element in shaping our present forests, its elimination can be expected to have profound effects, including the creation of climax stands with consequent reduction of wildlife habitat and commercially desirable seral tree species.



Roads can cause nearly irreversible forest disturbance. They disrupt natural seepage through the soil mantle and often convert it into overland flow. The effect of this disturbance on site quality is not well understood, and more research is needed to clarify the relationship. Roads on improper gradients and alignment and with inadequate drainage cause erosion and contribute to stream sedimentation. While roads provide access for hunters, they may also encourage traffic that harasses wildlife. In some cases the relationship of roads to animal habitats is also not well understood; cooperative studies on the subject are currently underway by the Montana Department of Fish and Game, the Forest Service, and the University of Montana.

Silvicultural practices should largely simulate or at least be in harmony with natural processes (21). But heavy equipment used in logging, slash disposal, and seedbed preparation causes soil compaction (30) and erosion. Infiltration tests have shown that water moves into the soil only half as fast on mechanically treated areas as it does on either burned soils or natural forest floor, and this condition can persist for long periods. Although slash burning causes air pollution, it is often a preferred practice from the standpoint of the forest ecosystem. This and other aspects of silviculture, such as the use of toxic chemicals as insecticides, herbicides, and silvicides, deserve more investigation. The effects of logging will be treated more thoroughly in following sections.

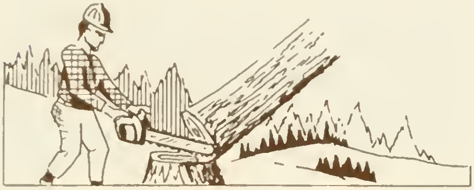
Effects of Timber Management On the Forest Ecosystem

Growth and harvest of commercial timber are major factors affecting forest ecosystems. Management considerations such as the desired products, species to favor, physical requirements of favored species, economics, and impact on values other than timber often determine which silvicultural system to apply. In many cases it is possible to select from alternative systems to minimize effects on ecosystem components, including wildlife, water, and the vegetational complex (26). Clearcutting is often the chosen method of harvest. It is almost always used in the case of disease- or insect-infested stands

Economic considerations, except on highly productive sites, require practices that lead to natural regeneration, a process less predictable than planting but less costly to apply. Combinations of natural reproduction with later fill-in plantings are frequently used on areas that fail to reproduce naturally within three to five years.

Cutting Methods

The basic methods are **clearcutting**, removal of all trees in blocks, patches, or strips; **seed tree cutting**, essentially a clearcut, with seed trees reserved as scattered individuals or in groups or strips; **shelterwood cutting**, where the stand is removed in two or more cuts 10 or more years apart; **group selection**, where many small openings (one to five acres) are made in the stand and allowed to reproduce before further cutting in the residual; and **single stem selection**,where single trees are cut, based on biological or financial maturity, in short cycles of 10 to 15 years.



The first three methods are most applicable to trees intolerant of shade, and regrowth will produce even-aged stands. The last two are applicable to shade-tolerant species and will result in multiple-aged stands. Table 1 summarizes recommended cutting methods for some of the principal timber types in Montana.

If timber production is the management objective, mature stands that have been decimated by insects, disease, or early cutting frequently require sanitation or improvement cuttings and overstory removal for the establishment of new stands. New stands, established either by favoring advanced reproduction or starting a completely new crop, are necessary to achieve the potential timber growth on the site (18).

Multiple use considerations: Each of the described cutting methods imposes particular impacts upon other values and uses of the land. This is a complex subject that will be discussed in subsequent sections. Table 2 compares the alternative cutting methods for one timber type, western larch, and rates the desirability of each method relative to its effect on other forest uses.

Thinnings and other intermediate cuttings affect the ecosystem much less drastically than do harvest cuttings, and their impact on most other forest uses is minimal by comparison. They are aimed primarily at improving structure and tree vigor in residual stands. Such methods are generally in harmony with natural development and can insure the maintenance of well-stocked stands.

Wildlife

Many animals make their homes and obtain food in the forest, and thereby alter the forest environment. Preferred plant species may be browsed into obscurity by excessive ungulate populations and reappear only if this pressure is reduced. Deer, elk, and moose damage seedlings; bears strip the bark from valuable trees; rodents girdle both seedlings and mature trees. Seed-eating rodents and birds also influence forest composition. Rodents that consume seed either in trees or on the ground usually obtain great quanitities from the larger species such as ponderosa pine and Douglas-fir. Animals reflect the vegetational changes caused by these activities by changes in their own numbers, productivity, and general welfare.

Animal niches: Wildlife ecologists view the forest as a spectrum of niches — unique habitat combinations that fulfill the needs of resident animal populations. Thus the diversity and abundance of animals in any given forest unit is directly related to the diversity and abundance of habitat at any point in time.

Niches vary both vertically and horizontally. Taber (29) has defined vertical forest niches as zones of outer air, outer surface, larger branches and trunks, shrub layer, and ground. Aerial predators feed upon prey produced in the forest and inhabiting the air around it. Other animals feed upon the buds, flowers, fruits, and leaves of trees. The larger branches and trunks provide homes for many birds and mammals and refuge and food for others. In all cases, these tree parts offer some protection from sun, wind, and rain.

The shrub layer provides nesting sites for birds as well as cover and nutritious, available food for these and for a wide variety of other animals ranging from mice to moose. Wildlife forage on the ground zone is augmented by fallen fruits and insects from the air, tree, and shrub zones. Underground is home for numerous burrowing animals, and it is here that predators such as foxes and coyotes make their dens. Perhaps because of our limited concept of ecology, the worms and insects that live in the ground are seldom considered when tallying faunal members of the forest community. These small organisms and the many microbes that occupy litter and soil are nevertheless essential to the forest's function.

Horizontal zonation may best be described in terms of the forest edge. In general, depending on the density of a forest, more light enters the edge, permitting a greater diversity of shrubs and herbaceous flora. Animals seek these plants because they are for the most part more nutritious then internal forest vegetation yet are close to cover. Also, nocturnal animals can safely venture from

Table 1: Summary of cutting methods recommended and practiced in forest stands in Montana *

Method of cutting	Western larch	Lodgepole pine	Douglas-fir	Ponderosa pine	Engelmann spruce and subalpine fir	Western white pine and associated species
Clearcutting	†1	†1	†2	3	††2	†††1
Seed tree	2	2	1	2	2	2
Shelterwood	2	2	2	1	2	2
Group selection	3	3	2	1	1	3
Stem selection	4	4	3	4	3	4

Legend. 1 most desirable, 2 good alternative; 3 least desirable; 4 not applicable.

† Sanitation requires clearcutting to remove infection sources in stands with heavy dwarfmistletoe infection.

†† Shade, preferably that cast by dead material, is required for successful germination and seedling survival.

††† Special measures are required to control the alternate host for white pine blister rust *Ribes* species, in stands containing western white pine. Often the best alternative is to favor one or more of the associated species over white pine because of the extreme difficulty in controlling blister rust

*Information obtained from Northwest Science and from publications of the Canadian Forestry Service Intermountain Forest and Range Experiment Station USDA Forest Service Montana Academy of Sciences Montana Forest and Conservation Experiment Station and Society of American Foresters

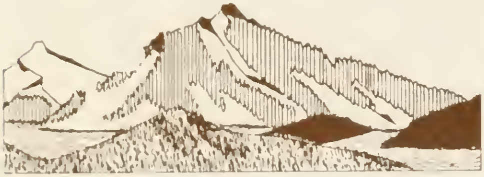
Table 2. Comparisons of cutting methods in relation to their impact on uses other than timber in western larch forests (24).

	Desirability (Least) 1	2	3	4	(Most) 5
Multiple use considerations					
1 Esthetic attraction	CC	ST	SW	GS	SS NC
2 Forage livestock					
Quantity and use	NC	SS	GS	SW	CC ST
3 Forage big game					
Quantity	NC	SS	SW	GS	CC ST
Use	NC	SS	CC ST	SW	GS
4 Timber production	NC	SS	GS	SW	CC ST
5 Water production					
Yield	NC	SS	GS	SW	CC ST
Quality	CC	ST	GS	SW	NC SS
6 Soil protection	CC	ST	SW GS	SS	NC

LEGEND
NC = No cutting
CC = Clearcutting
ST = Scattered seed tree cutting
SW = Shelterwood cutting
GS = Group selection cutting (groups one acre or less)
SS = Single stem selection cutting

the edge zone out into adjacent meadows or grasslands to forage. Edges within the forest itself are created by rockslides, streams, fires, blowdown, and rock outcrops. Man made edges are produced by roads, logging, clearing for structures, etc.

Forest density varies considerably depending on topography, soils, moisture, and past history. At some point in time, at a given place, a tree population reaches a maximum density, with a representative fauna. As the stand degenerates with age and the canopy is opened, resident animals reflect vegetational changes with changes in their own abundance and diversity, as noted earlier. Ecosystem disturbance accelerates the rate at which changes in its animal component take place. The composition and well-being of the animal community is also influenced by the nature of plant replacement, whether by chance (natural seed crops, root sprouting) or by design (prescribed fire, reforestation).



Timber harvest and wildlife: The wildlife component of natural forest communities can be drastically altered by timber management practices. Complete clearing will generally be accompanied by complete loss of forest fauna on the site and replacement by one that can adapt to the newly created conditions. Partial clearing usually increases forest-edge animals and/or species able to tolerate smaller habitat units and man's activities, but species dependent upon the internal forest habitat, and some larger ungulates and carnivores that conflict with man, will diminish in abundance or disappear. Forest managers should understand these relationships and evaluate public priorities before they implement timber harvest objectives.

Changes that can occur on sites from which the bulk of the trees are removed by logging include: drying out of the site from increased insolation and exposure to wind; increase in snow depths from decreased interception and evaporation caused by canopy removal; early snowmelt leading to change in peak flows of streams; and altered plant succession brought about by changes in moisture, light, and wind.

Changes in animal populations in response to the above and other site alterations caused by logging take several forms: Increased dryness can obviously affect animal habitat through changes in soil temperature, plant speciation, and cover characteristics. Increased snow depths in large openings may exceed a species' behavioral and physical limits. The effects on streams of channel alterations, siltation, and thermal pollution resulting from canopy removal may have consequent adverse effects on aquatic life (see following section). Improper slash disposal may create windrows and other barriers inimical to animal welfare. Forage and niche elements produced by even-aged or single-species management may increase the abundance of a few species (including some that threaten forest regeneration) at the expense of animal diversity.

The extensive road systems that usually accompany logging also cause severe and sudden disruptions of forest ecosystems. As noted previously, roading increases management opportunities when access is needed to distribute hunting pressure, but it also increases the game's vulnerability to both excessive and illegal killing, which in turn can cause deterioration of hunting quality. In addition, roads into hitherto undeveloped forestland constitute habitat loss for man-intolerant species such as the grizzly bear and eliminate options for wilderness or other natural-area designation that may benefit animal diversity. Whether or not increasing road access is beneficial to wildlife is a difficult decision for resource managers charged with responsibilities to provide a variety of experience to all citizens.

Animals adapt, move, or die if their environment is radically altered. Because wild species have evolved over many millennia, they cannot be expected to adapt successfully to sudden changes; nor do they have the unrestricted opportunity to move elsewhere. Logging that exposes game to hunting, removes shelter, scarifies a site to reduce grass, forb, and shrub competition, and is quickly followed by tree planting, can hardly be said to benefit wildlife. Because intensive forest management is seldom compatible with wildlife interests, and such wildlife benefits as do occur are almost always by accident rather than design, goals and priorities should be established for each area before timber harvest begins.

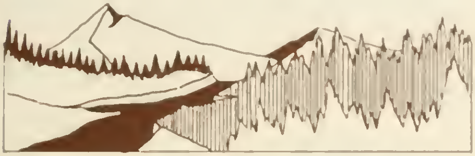
Water and Soil

Society's dependence on water cannot be questioned, nor can the value of water as a component of forested ecosystems. Montana streams are important tributaries of the Columbia and Missouri Rivers and thus add significantly to national power supplies and agricultural production. These same streams are valuable sources for municipal water supplies. Fish habitat, water for wildlife and domestic stock, and recreation opportunities depend on streams originating in Montana forests.

As the medium in which water moves and is stored and in which vegetation is anchored and grows, soil is a basic value of critical importance. The soil-vegetation complex of forests enables these ecosystems to withstand some manipulation and remain nearly in chemical balance. The limit of tolerance to manipulation beyond which the dynamic equilibrium of the ecosystem is jeopardized varies among forests and in many cases cannot now be predicted. The homeostatic capacity of the soil-vegetation complex and, for practical purposes, the soil's nonrenewability, have recently caused much concern about the ecological effects of forest management.

The intensity of forest management is on a gradient from wilderness preservation to commercial timber harvest that involves clearcutting, burning, and drastic seedbed preparation such as the terracing in the Bitterroot River drainage (4). Similarly, forest ecosystems form a gradient in their ability to recover from a particular management practice — in their capacity to resist erosion, structural alteration of soil, and leaching of soil nutrients with concomitant stream eutrophication. Also, forested watersheds, or even areas of the same watershed, differ in terms of management effects on volume, timing, and quality of stream runoff.

Almost without exception, reduction of the vegetational biomass of a forest causes increased runoff (17). Reduced transpiration from the smaller living-leaf-surface area will usually more than compensate for any additional evaporation. Even on clearcut watersheds, where evaporation may be much increased by higher insolation and wind velocities, runoff is substantially greater than that of similar uncut areas. No published data were found for Montana, but directionally uniform results from studies throughout the world lead us to predict that reduction of forest cover will increase streamflow from Montana drainages while establishment of forest vegetation on nonforested sites will reduce it.

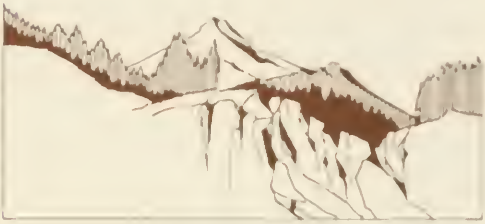


Timing of stream runoff is responsible for floods and droughts. Proper management can reduce the likelihood of these occurences (25), conversely, poor management can increase their probability. Impairment of water quality by forest operations includes high turbidity caused by erosion from disturbed watersheds. Erosion also causes heavy bedloads in streams, which can silt reservoirs and destroy fish-spawning grounds. In addition, water quality is affected by an increase in dissolved nutrients. In some nutrient-poor mountain streams, this can increase fish productivity. However, too great an increase may cause eutrophication and reduce fish production.

Valuable information from the Weisel and Newell study (34) on slightly disturbed watersheds in western Montana has been badly misinterpreted to indicate that logging does not significantly affect the dissolved nutrient levels of streams (2, 31). Weisel has in fact concluded that it does, but that the increase in dissolved nutrients from extremely careful logging was not significant on a nearly flat site, an atypical situation in the study area. The results of another study, sponsored by the Forest Service, provide additional information on the quality of Montana streams flowing through both managed and unmanaged watersheds (27, 28).

We mentioned in the wildlife section that management practices can lead to increased water temperature. Although in some cases slightly higher temperatures may improve fish productivity, native species may be adversely affected. Also, disruption of riparian or streamside vegetation can lead to cooler than normal water temperatures in winter, and this too can be deleterious to developing fish.

Many effects on stream quality are caused by changes in soil characteristics. Overland runoff can be increased by logging, roading, or any other forest disturbance that reduces the soil's infiltration capacity. This may produce higher erosional rates, and the resulting sediments frequently reach stream channels (22). Futhermore, management practices may lead to significant soil deterioration (7).



The most drastic soil losses occur where much of the vegetation has been destroyed. Mass erosional hazards are greatest on steep slopes with deep soils and moist conditions. The geologic parent materials, soil type, and water table level must also be considered when evaluating a site's erosion potential (14). More subtle but very important effects on soil, involving dissolved nutrients, also result from forest management. Whether the removal of vegetation and subsequent loss of nutrients from the ecosystem may cause long-term reduction of forest productivity is a hotly debated issue (7, 13, 31). Increased nutrient loss following forest manipulation has been observed (20, 12), but the amount lost, the time required for forest recovery, and the overall significance of the losses are variable.

Very few publications describe the effects of timber management on soil and water parameters in Montana, although some research is in process, including a study by the Intermountain Forest and Range Experiment Station and Region 1 of the Forest Service of the role of burning on soil stability, water runoff, and water quality (6). Also, the Montana Forest and Conservation Experiment Station (University of Montana) is conducting a multidisciplinary study — the Lubrecht ecosystem project — on the safe limits of forest manipulation in Montana, including the effects of management disturbances on soil and water (3).

Conclusions. Although Montana information is slight, several general conclusions can be drawn from research conducted elsewhere. The effects of timber management on our soil and water resources can be deleterious and long lasting. One of the prime causes of increased erosion on managed forests is road construction (11, 2), and it is particularly important that roads be carefully planned and harvesting operations that minimize roading be encouraged (22). However, vegetation removal and regeneration failure can cause substantial stream eutrophication even in the absence of roads (20).

Frequently the impact of management on an ecosystem is viewed only with respect to the part directly modified, despite the fact that manipulation can profoundly affect the whole system as well as surrounding and sometimes even distant systems. Management plans should not be developed without considering all these relationships.

At the same time, each management area must be analyzed as a separate unit. Dils (9), when discussing clearcutting in the northern Rockies, stated that the adverse influences of the practice ". . . would be most intense on poor sites (thin, rocky soils), on southern exposures, on fragile subalpine areas, on steep erosive slopes, and on very dry sites." Such sites should be evaluated with special care before doing anything that would substantially disrupt the vegetative cover. In general, practices that least disrupt soil surface and vegetation will cause the least disruption of soil and water, although the beneficial aspects of fire as a natural disturbance lead to caution regarding that generalization.

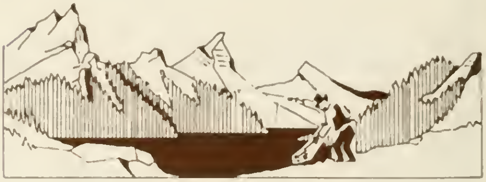
Finally, Bormann (5) has warned about potentially serious problems from multiple disturbance to ecosystems, especially when several of the disturbances are very subtle. For example, air pollution, in addition to timber harvesting, causes an increase in streamwater nutrients through its influence on soil processes. The combined effect of these two disturbances should be evaluated when predicting the consequences of management in areas near urban centers.

Recreation and Esthetics

Montana's forestlands are of unquestionable value as sources of raw materials such as wood, water, minerals, and forage. These lands also provide less tangible products — the sights, smells, and sounds of nature. They are the recreational and esthetic environment that gives pleasure and meaning to the lives of thousands of Montanans and out-of-state visitors. From this perspective we must view the forest not merely as a source of materials but as the setting for a much greater spectrum of human needs.

Montana has no giant metropolitan complexes where the natural landscape is no longer evident. All of our urban areas are surrounded by or intermingled with forest and rangelands that provide the open space many large cities are struggling to preserve. This close urban-wildlands relationship puts forest management under continuous, close public scrutiny. The need for timber management that conforms to ecological controls has been discussed at some length. Growing public recognition of the forest's value as a total environment means that management must also conform to esthetic and recreational controls.

The forestlands of Montana offer a tremendous range of recreational opportunities, which vary as to their compatibility with timber production. In the case of developed (or mass) recreation, timber management can be modified to enhance recreational and esthetic resources. Timber stands in campgrounds and picnic areas can be selectively cut to remove individual trees that either are safety hazards or prevent the desirable pattern of facility development. Carefully planned cuttings can open up scenic vistas along roads and trails. Cuttings and subsequent regeneration can add variety to monotonous, even-aged, single-species stands, such as the lodgepole "dog-hair" mentioned earlier.



Large expanses of forestland can sometimes include intensive timber management without impairment of recreation values. However, this requires careful planning and administration of the sale program. In sensitive scenic and recreation areas, clearcutting is obviously undesirable. In others it may be a suitable method if small cuts are used and if cutting-unit boundaries blend with natural features. Logging must be timed so that entire drainages are not cut over in a short period and the area left denuded. New logging techniques, including some that require fewer roads, may possibly reduce the visual scars as well as the ecological impact of timber removal.

In still other situations, recreational and other nonmaterial values are such that timber harvest must be precluded. This of course is true in dedicated wilderness. It should also apply to many natural areas not so designated and to lands adjacent to population densities or transportation routes where scenic values are critical.

Timber management thus cannot be described as categorically good or bad for recreation and esthetics. Its impact depends to a large extent on the degree and conceptual quality of study and planning given to each management decision and on the amount of sensitivity used in carrying out the program.

Environmental Quality Control

Patterns of forestland use are dynamic. They change according to economic conditions, technological development, advances in knowledge of soils and biological elements, political pressures, and the needs and interests of the public. Until recently, as economics and technology created a demand for wood fiber, the allowable cut on public land was increased. Now, however, because of rising public concern, expanding recreational use, and more recognition of the effects of timber harvest on soil, water, and wildlife, government agencies and several industrial owners of forestland are reevaluating timber management practices and are altering their harvest plans. This is leading to a reduction in the allowable cut (36).

The Forest Service is revising multiple use plans on all national forests in Montana. A "marginal" designation is given to certain lands because of slope, soils, geology, or stand quality, in which case cutting may be deferred until safer harvest technology is developed. Lands under consideration for wilderness or wild and scenic river classification are deferred from harvest while their legal status is under review. New standards of management are also modifying timber sales already under contract, such as one on Bunker Creek in the Flathead National Forest, to better protect environmental and amenity values.

The shift in timber management is placing greater emphasis on highly productive timberlands and less on lands of low productivity. Intensified management of the former, if properly funded, can perhaps restore timber production to the higher levels once estimated, or even exceed those levels. Such a shift would also provide greater flexibility in satisfying other uses of forestland on sites less suitable for timber growth.

Management in Harmony with Nature

A review of current timber management suggests that disruptive practices occur all too frequently. We would define heavy-handed management as the imposition of land use decisions regardless of restraints and controls required by the land itself. This is true in forest management whether the subject is recreation planning, water development, timber harvesting, or anything else, however, as throughout this paper, we will confine our discussion to timber practices.

On forestland where timber production is a primary management focus, highly productive soil may also be highly erosive. An extreme example of heavy-handed management here would be massive road construction and dozer logging. A light-handed, or sensitive, approach would be logging methods that disturb the ground surface very little, such as helicopter or overhead cable systems. But, to conform to the constraints of the land, harvesting costs would be higher.

On forestland where timber production and other uses are compatible, sensitive management could include the practices described in the recreation section as well as growing species that do not require harvest by clearcutting, although these species would be less desirable for lumber. Full-tree logging to concentrate slash and reduce fire potential (or mechanical chippers to reduce air pollution) would also minimize environmental disturbance, as would a return to horse logging.

As management in Montana deals less with virgin forests and more with second-growth timber, huge harvesting equipment will give way to smaller, more mobile machinery that can move through the woods for longer distances with less damage to surrounding vegetation. To make harvesting of smaller trees more economical, more timber may have to be processed in the woods and finished or semifinished products hauled to a central point.

In the construction of forest roads, sensitive management would dictate that the shortest distance between two points is not always the best route. A road that conforms to the topography would be preferred to a more direct road with huge cuts and fills. This might mean a more costly and winding road but one that rests more lightly on the land. The same philosophy would also mean fewer roads on a given area, which in turn would increase harvesting costs.

The various management measures considered above may seem far removed from present economic reality, for they will raise the cost of forest use and forest products. They are essential, however, if our demands for these products are to be met without intolerable disruption of the forest environment.

Conclusion

Much of the controversy over past management of Montana forestlands arose from the tendency to make blanket recommendations for timber harvest methods. While this approach made administration and harvest operations easier, it did not make biological, economic, and esthetic sense. Among other things, it did not properly account for the wide variation in environmental capacities and conditions. We are moving rapidly toward a new system best described as "systematic situational resource management."

The new system will require a detailed ecosystem inventory for each management area, including analysis of physical, biological, social, and economic factors, and determination of the anticipated effects of manipulation. It will also require a dynamic multiple use plan that provides for reanalysis and replanning, a well-balanced staff of professionals to direct and support field personnel charged with situational management, a vigorous research program, and more widespread incorporation of informed public participation.

Within ecosystem limits, careful planning and management can increase some of the multiple values of Montana forests. Others, equally important, cannot be increased but only restored or preserved. Management that understands and respects the limits of the forest ecosystem, and gives primary consideration to the basic natural values that underlie all its manipulable components and multiple uses, will conserve the land and benefit its users.

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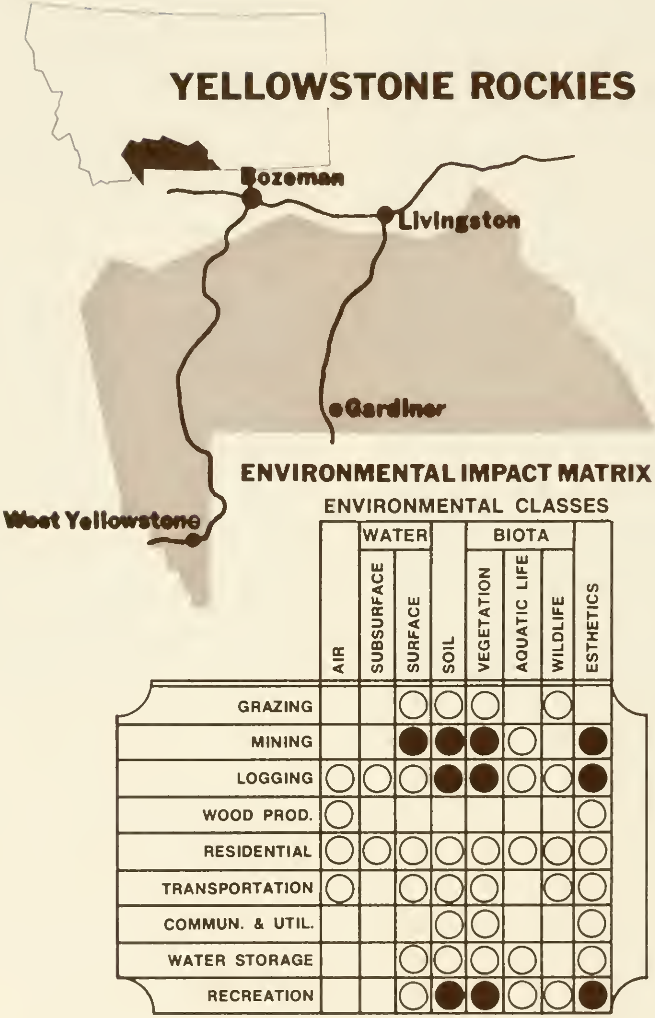
YELLOWSTONE ROCKIES



ENVIRONMENTAL IMPACT MATRIX

ENVIRONMENTAL CLASSES

		WATER			BIOTA			
	AIR	SUBSURFACE	SURFACE	SOIL	VEGETATION	AQUATIC LIFE	WILDLIFE	ESTHETICS
GRAZING			○	○	○		○	
MINING			●	●	●	○		●
LOGGING	○	○	○	●	●	○	○	●
WOOD PROD.	○							○
RESIDENTIAL	○	○	○	○	○	○	○	○
TRANSPORTATION	○		○	○	○		○	○
COMMUN. & UTIL.				○	○			○
WATER STORAGE			○	○	○	○		○
RECREATION			○	●	●	○	○	●

○ MINOR
● MAJOR

Environmental Perspective

Yellowstone rockies

The commanding feature of this region is its majestic mountains, which hold more than 25 peaks above 12,000 feet, including Granite Peak, the highest in Montana. Vast reaches of wild secluded land lie behind the great ramparts of the Beartooth, Absaroka, Gallatin, and Madison Ranges, which in many places rise almost perpendicular from the valley floors. Glaciers and snowfields ride the flanks of the uppermost peaks, and their waters feed hundreds of streams and lakes. A special quality of the Yellowstone Rockies derives from its great expanses of alpine and subalpine plateaus, their sweeping meadows a profusion of wildflowers. It is probable that the last Chief of the Crow, Plenty Coups (1848-1932), had these mountains in mind when he said

> **Of all things created, the mountains only have escaped the domination of the white man. The valleys are scarred by the plowman, ridged by the trailmaker and guttered by the taker of water, but the mountains are still as God made them, and to be near them is to be on the pathway to peace.**

Although the natural landscape of the Yellowstone Rockies is increasingly modified by human activities, an environment of such high quality persists that the name "Paradise," given to a portion of the upper Yellowstone Valley, is still not inappropriate for the region as a whole.

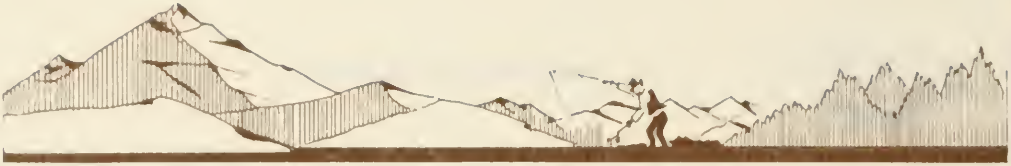
Environmental monitoring is recent and sporadic in the region and data are sparse, even more so than in the Columbia Rockies. For many years the austerity and inaccessibility of much of the Yellowstone Rockies kept the region largely undefiled by man, thus precluding the necessity for auditing environmental health. Recently, however, interest in the region's mineral, water, timber, and recreational resources has stimulated awareness of existing and potential environmental degradation related to development activities. Monitoring has been initiated at a handful of disconnected locations where development is imminent and baseline information is wanting. In most cases measurement of environmental parameters will continue through only the initial active stages of development, in others it will continue beyond.

With more than 80 percent of its nearly 5,000 square miles in public ownership, with a resident population of less than 3,000, and with its intrinsic environmental amenities, the Yellowstone Rockies provides outdoor recreation opportunities that are varied, extensive, and of the finest quality.

The region is composed principally of portions of Yellowstone National Park (171,077 acres) and three national forests — the Beaverhead, Gallatin, and Custer. It also contains in their entirety the Spanish Peaks (50,000 acres), Absaroka (64,000 acres), and Beartooth (230,000 acres) Primitive Areas, representing 11 percent of the region's total land. Portions of four roadless areas — the North Absaroka, Hilgard, Lionhead, and Hyalite — may be proposed for wilderness study. Many thousands of additional acres of undesignated wildland qualify for inclusion in the National Wilderness Preservation System. Countless miles of jeep, horse, foot, and game trails traverse the mountains. The Forest Service maintains 36 campgrounds and two picnic areas in the region. Within the Gallatin National Forest are the Madison River Canyon earthquake area and the Big Sky snowmobile trail.

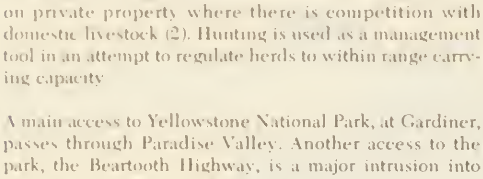
Three nationally renowned Class I "blue ribbon" trout streams originate in the Yellowstone Rockies. The 45 miles of blue ribbon water of one, the West Gallatin River, are situated wholly within the region, which also contains about 70 additional miles of Class I waters in the Yellowstone and Madison Rivers. Many miles of lesser-class but still excellent fishing streams, as well as the multitude of lakes, contribute to the region's outstanding fisheries resource. To facilitate fishermen access to these waters the Montana Fish and Game Commission has established 12 sites totaling 532 acres.

Hunting quality in the Yellowstone Rockies is likewise excellent, with harvestable populations of deer, elk, moose, sheep, goat, and bear. To help perpetuate this valuable resource the commission has acquired by purchase or lease 16,934 acres of game range. However, deer and elk winter range conditions have gradually deteriorated over the years, with the present deer range rated very poor to fair and the elk range poor to good (2). Ecological stability of the Yellowstone and Gallatin Valleys was disrupted in the early years of human settlement by elimination of the large predators and preemption



of winter game range by a variety of human uses, the first of a long series of land use tradeoffs. Without natural controls, large ungulate populations increased; at the same time, available range became more and more restricted. A large percentage of deer and elk winter range is now on private property where there is competition with domestic livestock (2). Hunting is used as a management tool in an attempt to regulate herds to within range carrying capacity.

A main access to Yellowstone National Park, at Gardiner, passes through Paradise Valley. Another access to the park, the Beartooth Highway, is a major intrusion into the high-mountain wildlands of the region, while at the same time offering motorists visual enjoyment of some of the nation's most spectacular alpine scenery. These components of the transportation system, combined with others leading to the West Yellowstone entrance to the park, produce one of the heaviest environmental impacts upon the Yellowstone Rockies — recreation use. Presence of a national destination point — the park — plus the region's extreme attractiveness for both Montanans and nonresidents result in over two million visitor-days annually in the region. Recreationists seeking the environmental amenities bring substantial pressures upon the very resources they hope to enjoy.



Meeting the requirements of recreational visitors for overnight accomodations, sanitary services, solid waste disposal, parking space, etc. without adding to degradation of air, water, land and biotic quality is a great challenge to land managers and private enterprises. A special challenge is presented in areas where black and grizzly bears are quick to take advantage of available food or garbage. Conflicts between humans and biotic elements usually are resolved in favor of humans, with consequent long-term alterations of ecosystems. Attempts to save problem bears by transplanting them to more remote areas within the region have met with substantial opposition and have caused a high fatality rate among the bears.

The Yellowstone Rockies has sustained adverse impacts from off-road use of recreation vehicles and from recreation-livestock grazing, especially in the vicinity of fishing lakes. Off-road traffic on unsuitable terrain and soils, notably in alpine areas, has necessitated closure of several areas to motorized vehicles. Probably more should be similarly protected. The severity of the problem, which is nationwide, is reflected in the recently announced Forest Service regulations against all off-road vehicles (other than snowmobiles) except on certain designated trails. In some national forests, including those of the Yellowstone Rockies, tentative plans are to put the regulation into effect before the 1973 field season (1). Other federal land management agencies are also establishing regulations to implement a Presidential executive order concerning off-road vehicles on public lands. Hopefully the new controls may alleviate some of the environmental abuse from this practice.

While constraints have not been broadly applied to recreational use of livestock in primitive areas and other wildlands, such restrictions appear necessary and are probably not far off. Grazing by sheep and cattle is a traditional use that has also had some adverse effects. On the Gallatin National Forest in 1971, sheep numbers were only a third (9,600 head) but cattle numbers were twice (15,000 head) what they were 30 years before. No serious impacts from cattle and sheep grazing have been encountered at lower elevations, although there is room for range improvement. In the high country, however, range deterioration has occurred in the Boulder-Absaroka area and along the Madison Divide.

Environmental impacts from activities of the region's permanent residents are limited by the sparse population of less than one person per square mile. Available space for human occupancy is restricted by federal ownership of most of the land. Consequently, tradeoffs between competing uses of private lands are common, with increasing allocation of private forest or agricultural and grazing lands to recreational purposes, such as commercial campgrounds, second-home subdivisions, and corporate recreational real estate developments.

The entire ecologic, economic, social, and esthetic character of a western portion of the Yellowstone Rockies — the Gallatin Canyon — is undergoing a rapid transformation as a result of the last. What has been a quiet, sparsely settled corridor to Yellowstone Park is now becoming a bustling recreational center in its own right. In a few short years the Big Sky resort complex will establish a small city in what had been a semiprimitive environment. If the development is completed as planned, the resort population of perhaps 10,000 persons will be accommodated by condominiums, homesites, an 18-hole golf course, a 50-acre lake, tennis courts, a swimming pool, a trap- and skeet-shooting facility, a dude ranch, rodeo grounds, equestrian showgrounds, camping and skiing facilities, a complete shopping center including bank and barber shop, a bowling alley, sauna baths and health spa, a filling station, seven restaurants, and two tertiary sewage-treatment plants. Twentieth-century living, with all its comforts and ills, is clearly supplanting the rustic atmosphere of the Gallatin Canyon.

Three land exchanges between the Forest Service and Burlington Northern Railroad will result in consolidation of a large tract of privately owned land in the West Fork basin, the principal focus of development activity. The Forest Service now controls 50 percent of the land in this area. Upon consummation of the exchanges (unless a current court appeal is upheld) the government will control only 28 percent of the land, with the remaining 72 percent in private ownership (5), thus allowing for extensive real estate development.

Although the principal developer in the West Fork Basin — Chrysler Realty Corporation's Big Sky of Montana — appears to have included adequate environmental safeguards into its planning, there is widespread distress over potential environmental and esthetic degradation caused by the anticipated influx of people and by the inevitable proliferation of peripheral developments. In addition, secondary impacts are now becoming apparent, such as supplemental power transmission lines strung through the Gallatin Canyon by the Montana Power Company to serve the new development. Other impacts will reach beyond the Gallatin Canyon itself; for example, the expected increase in air traffic will necessitate expansion of Gallatin Field at Belgrade.

Consumptive human uses of public forestland — logging, water supply development, and mineral exploration and mining — have all caused alterations in the natural environment of the Yellowstone Rockies, both at the point of extraction and at the location of processing.

Although air quality is generally excellent in the region, it is susceptible to intrusions of pollutants from external sources, including petroleum refineries, forest fires, and agricultural and slash burning. Specific localized air quality problems originating within the region itself include those initiated by construction, logging, wood processing and community activities.

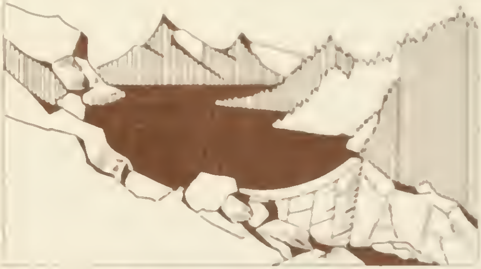
Impacts of logging upon air quality include dust generated by trucks traversing unpaved roads and a relatively minor amount (compared to other national forests) of slash burning. During 1971 slash was burned a maximum of 19 days on the Gallatin and Custer National Forests. The bulk of these forests is within the region, although smaller parcels, on which some of this burning may have occurred, lie outside the Yellowstone Rockies.

West Yellowstone (year round population about 800, estimated summer population 15,000) is the region's single most important source of air contaminants. Many of the town's seven to 10 miles of streets and alleys are unpaved, and many of the paved streets are very dirty, creating a substantial dust problem, especially during the summer tourist season. Open burning is allowed with a permit. A local wood products firm has had a very poor record of compliance with waste-burning regulations.

These factors have caused West Yellowstone to exceed the state ambient air quality standards for suspended particulate and dustfall. An average of 240 micrograms of total suspended particulate per cubic meter of air was calculated for a total of 60 samples from the 1967-68 sampling season (3). This is well in excess of the allowable annual mean of 60 micrograms. Dustfall at all three sampling stations in West Yellowstone exceeded the state standard from March through August in 1968. Three-month averages, expressed in tons of settled particulate per square mile, ranged from 16.76 to 301.53 for that period (3). The Montana standard is only 15 tons per square mile in residential areas. As of December 31, 1970 the town was in violation of state air quality regulations in three categories: occasional burning of garbage and trash, uncontrolled open burning, and lack of a dust-control program (1). As of December 31, 1971, however, it had an approved landfill disposal facility.

Air quality is also being monitored relative to the Big Sky operation. Measurements by the Montana State University Gallatin Canyon Study Team, as yet unpublished, indicated consistently pure air in the West Fork Basin prior to commencement of construction. Monitoring will probably continue in this area only for another year or two.

Water supply development has modified natural conditions in several localities in the Yellowstone Rockies in projects for municipal water (Mystic Lake, Bozeman Creek), for irrigation (Glacier Lake), and for power generation (Hebgen and Mystic West Rosebud reservoirs). As part of a plan to supply electrical power for rural development downstream, Bureau of Reclamation proposals to construct Allenspur Dam on the Yellowstone just above Livingston have resurfaced. Such a dam would inundate much of Paradise Valley and completely obliterate a river reach highly valued for its scenic and recreation assets.



Water quality, like air quality, is generally excellent in the region. Baseline data have been collected in a number of drainages by a variety of agencies, and monitoring continues in areas where mining, timber, and recreational development are imminent or established.

The aforementioned Montana State University study team is measuring certain physical, chemical, and biological water parameters on the Gallatin River and tributaries in anticipation of the Big Sky complex and satellite developments. Forest Service personnel are monitoring physical water quality at 11 stations on these same streams, checking response to watershed management practices. In the Absaroka-Beartooth area, monitoring is being conducted above and below active mineral exploration sites, particularly in the Stillwater Complex. Details of this program are given in the contributed paper by Bob Anderson.

Approximately half of the sewered population of the Yellowstone Rockies resides in West Yellowstone and is served by a secondary treatment facility (sewage lagoon). The other half, in Gardiner, is serviced by septic tank or primary treatment. Gardiner is scheduled to begin secondary treatment of its sewage by 1974. All other communities in the region are unsewered.

All public drinking water supplies in the Yellowstone Rockies passed U. S. Public Health Service standards when inspected by the state health department in 1971. One municipal water supply, Cooke City's (50 users), had a slight indication of coliform contamination (possibly from recently installed pipes), but this was considered insufficient to warrant an unsatisfactory rating.

Environmental impacts caused by mining and mineral exploration have occurred primarily in the Absaroka-Beartooth portion of the region. These impacts also will be identified in detail in Bob Anderson's paper, which follows. Any perspective for the Yellowstone Rockies must focus on the fate of the region's most extensive and valuable resource — its magnificent mountain wildlands. Wilderness proposals for the Absaroka-Beartooth are a major environmental issue, as Mr. Anderson will note. Protection for other outstanding wild areas is equally important in terms of the character and quality of the Yellowstone Rockies and the continuation of its mountains ". . . still as God made them . . . the pathway to peace."

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ABSAROKA-BEARTOOTH AREA

by
Bob Anderson

General Description

The Absaroka-Beartooth is a mountainous area of about a million and a half acres that lies north and northeast of Yellowstone National Park. The land is predominately wild; therefore the environmental quality is for the most part little affected by man.

Because of the wide elevation range (from about 5,000 to nearly 13,000 feet) the topography, landforms, and vegetation types are extremely varied. Along the elevation gradient, vegetation types include grasslands, forest bogs, aspen thickets, Douglas-fir and lodgepole pine forests, mountain meadows, subalpine forests, subalpine meadows, alpine meadows, and barren rock outcroppings. These vegetation types (or ecosystems) vary in their response to manipulation or alteration. In general, diversity decreases, stability decreases, and sensitivity increases with increasing elevation.

The climate likewise shows extreme variations along the elevation gradient — semiarid in the lowlands and subarctic in the heights.

Man's overall impact on the environment has been minor for two reasons (1). First, the area has a dearth of developable resources. Second, the austerity of the climate and physiography is not conducive to human habitation.

Conditions and Trends

Air

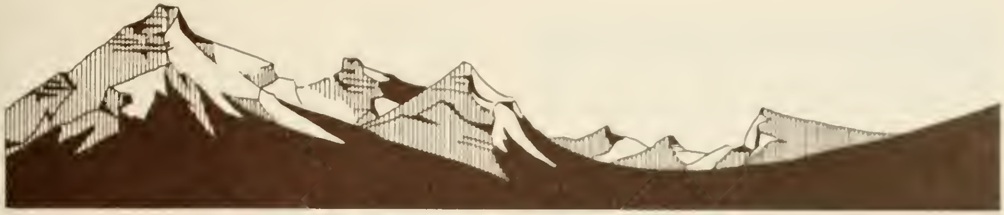
In general, though there are no known measurements of its parameters, air quality is very good. Occasionally, particulates from oil refineries at Laurel or Billings, from agricultural burning in the lower valleys, or from slash burning or forest fires in other areas may lower visibility (11, 12, 13).

The area has had no major forest fires since the Horseshoe Basin fire in 1953. Slash burning is minimal because of the limited amount of timber harvested but can, during critical meteorological conditions, contribute to local and regional air pollution problems.

Water

Because of the lack of man's intrusion and the durability of the rocks that cover most of the area, water quality is generally excellent. The importance of this quality is emphasized by high surface-water yields — 1.0-2.6 acre-feet per acre per year (11).

Water quality information is limited, but some data have been collected on the Boulder River, the Stillwater River,



the West Fork of the Stillwater River, East and West Rosebud Creeks, Rock Creek, and the West Fork of Rock Creek. These data indicate that, except during peak runoff, turbidity is less than 1 JTU (Jackson turbidity units). At the national forest boundaries, water temperature highs range from 11-16°C. From fall to spring, temperatures vary from 1-4°C. Hardness is usually from 15-40 mg/l (as $CaCO_3$). Alkalinity varies from 15-35 mg/l (as $CaCO_3$) and sulfate from 1-3 mg/l. Iron is ussually less than 0.08 mg/l (11).

A slight deviance from the excellent water quality in the Absaroka-Beartooth is measurable in the West Fork of the Stillwater and the Stillwater Rivers, where hardness may range up to 80 mg/l, alkalinity to 60 mg/l, and sulfate to 15 mg/l (11). Though all of these data fall well within the U. S. Public Health Service drinking water standards, they probably reflect the impact of mining and mineral exploration in those two drainages.

In the Stillwater River and East and West Rosebud Creeks, samples have shown that from 70 to 100 percent of the bottom fauna are pollution-sensitive aquatic insect orders such as Plecoptera (stoneflies), Tricoptera (caddisflies), and Ephemeroptera (mayflies) (11).

A notable exception to the usual high water quality occurs in the Daisy Pass-Lulu Pass area near Cooke City. Here, mining has aggravated an acid drainage situation resulting from soils and rocks high in sulfides. Fisher Creek (a tributary to the Clark Fork of the Yellowstone) and a small stream in the headwaters of the Stillwater River have demonstrated waters high in hardness (105 mg/l as $CaCO_3$), alkalinity (60 mg/l), sulfate (60 mg/l, iron (1.5 mg/l), copper (0.7 mg/l), and turbidity (>200 JTU) (11).

At and near Goose Lake (near Cooke City), mineral exploration has resulted in serious siltation of spawning grounds for cutthroat trout.

Though no data are available, water quality in the Absaroka streams that drain southward into Yellowstone Park is probably not as high as in streams that drain the Beartooth (streams mentioned in the second paragraph of this subsection) (11). In the southern Absaroka, the rocks are less resistant volcanic and sedimentary materials and the soils are deeper and better developed (3). The water here is surely more sensitive to disruption and development. In fact, the spring sediment load in Bear Creek (near Jardine) was reported to increase after clearcut logging in the drainage in the early 1950's (11).

One of the most serious environmental questions in the Absaroka-Beartooth is: What will be the effect on water quality of mining activities in the Stillwater Complex?

This complex, a formation stretching from East Fishtail Creek to the main Boulder River in the northern portion of the area, is known to contain vast but low-grade deposits of a number of metallic ores (1,9,11). Recently renewed exploration suggests that it is merely a question of time, economics, and technology before large-scale development occurs.

Looking ahead, a number of organizations including the Forest Service, the Montana Department of Health and Environmental Sciences, the Montana Department of Fish and Game, the U. S. Geological Survey, the Anaconda Company, AMAX Mining Company, Johns Manville Mining Company, and Cyprus Mining Company have begun a cooperative monitoring program to establish a baseline of water quality and to detect changes resulting from mining-related activities. Data from a network of about 100 monitoring stations, most in the Stillwater Complex, are stored for easy retrieval in an automated data-processing system at the Denver office of the Environmental Protection Agency (5).

Among the parameters being measured in the field are discharge, dissolved oxygen, conductivity, alkalinity, pH, temperature, and turbidity. Laboratory analyses include calcium, magnesium, sodium, potassium, iron, manganese, aluminum, silica, bicarbonate, carbonate, hydroxide, chloride, sulfate, nitrate, fluoride, phosphate, copper, nickel, zinc, cadmium, pH, hardness, sodium absorption ratio, specific conductance, alkalinity, and total dissolved solids. Flora and fauna are inventoried at the same stations (5).

Land

GEOLOGY

Bedrock geology has a significant influence on soils and a number of other important environmental features. The Beartooth Uplift is a block of Precambrian gneiss and schist that extends from the northern Absaroka to and including the vast Beartooth Plateau (2). These rocks are highly resistant to erosion, thus soils are poorly developed and productivity is low. The dominant land forming process is glaciation, both shield (or continental) and alpine (or valley) types. The southern Absaroka, on the other hand, is underlain by less durable Tertiary volcanic and sedimentary materials. Here weathering has resulted in deeper soils, sometimes with high clay content (11, 12).

MINERALS

The Absaroka-Beartooth has been thoroughly explored by minerals prospectors since the late 1800's. Most of the exploration has proven fruitless, but a number of valuable deposits have been developed. Major exploration and/or extraction sites are

Stillwater Complex This area contains dozer trails, roads, discovery pits, trenches, drill sites, tailing ponds, and shafts, some historic and some recent. In accordance with 1971 Montana legislation and cooperative agreements between the Forest Service and involved mining concerns, concerted efforts have been made to repair many of the old scars and all of the recent ones and to conduct current exploration in an environmentally considerate manner. The Forest Service has prescribed such things as road construction standards and seed mixtures for revegetation of disturbed sites.

Several difficult problems face the reclamation program. Most of the work is at high elevations, where temperatures are low, the growing season is short, and soils are poorly developed; thus natural processes are slow. There are no other known reclamation projects in similar environments. Supplies of seeds of native vegetation are not available.

As of the winter of 1972 the program is about 60-percent completed as prescribed. It is too early to evaluate the success of the work (3).

New World Mining District Located near Cooke City, the district produced a variety of minerals valued at $34 million from 1900 to 1933 (9). Fisher Mountain and many surrounding locations have been denuded of vegetation and piled with dumps and tailings. Because of high sulfides in soils, vegetation cannot grow and drainage is acidic.

Jardine Mining District Here nearly $7 million in minerals was produced between 1900 and 1948 (9). The environmental result has been unsightly tailings ponds and heavy-metals contamination of Bear Creek (4).

Crevasse Mining District Activities between 1901 and 1939 produced minerals worth $70,000 (9). A number of abandoned shafts, dumps, head frames, and cabins remain.

Cowles-Independence District Active in the late 1800's, the district has been dormant since 1934 (9). Mining and milling equipment as well as abandoned shafts decorate this scenic area

Emigrant Mining District From 1900 to 1930 nearly $500,000 in gold and silver was produced here (9). Unsightly dozer trails and discovery pits are the result of recently renewed exploration.

Goose Lake District (See previous section on water quality.) Exploration dating back to 1885 has scarred the landscape, which shows little evidence of natural recovery because of the austere environment (12).

Horseshoe Basin Indiscriminate bulldozing in a dry alpine ecosystem has caused appalling degradation of the visual landscape. There is little evidence of the active mining that took place at the turn of the century.

Hellroaring Plateau Several thousand tons of low-grade chromite and chrome concentrate were produced here during World War II (11). The old mining road has provided motorized access to a fragile alpine ecosystem. The potential for overuse by recreational vehicles is high.

Other sites of minor and apparently insignificant exploration include: Boulder Mountain, Bridge Creek, Great Falls Creek, Haystack Mountain, Mt. Cowan, Mt Wood, and East Fork Main Boulder River (9,11). Impacts have been negligible, and most of these areas are reverting to natural conditions.

SOILS

Soils in the Beartooth are typically shallow, coarse, or gravelly loams with little clay development and high erosion potential. On undisturbed sites, erosion is minimal and soil stability problems are few because the soils are well drained, shallow, and have little clay content (1,6,7,8,11).

In the southern Absaroka, as noted previously, soils are much deeper, better developed, sometimes poorly drained, and often possessing a high clay content. Soils are less susceptible to erosion here, but the eroded clay-sized particles remain in suspension and cause turbidity in runoff water. In areas of steep slopes, high precipitation, poor drainage, and/or high clay content, the landforms are often unstable. Many sites exhibit active land movement. Others have the potential if disturbed (12).

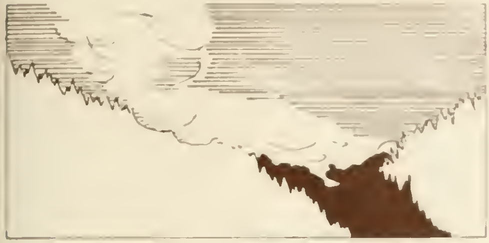
RANGE AND FORAGE

At one time nearly every open patch of vegetation in the Absaroka-Beartooth was stocked with sheep in the summer months. Overgrazing caused competition with wild animals, invasion by less desirable plants, soil erosion, and stream siltation. High transportation costs, limited availability of dependable herders, and range deterioration have led to a marked reduction of permited sheep to 7,100. Range conditions indicate that this number should be further reduced (11).

Within the Absaroka Primitive Area grazing has not been allowed except for recreational stock. The range there is generally in good to excellent condition (11).

FIRE

This was once a natural phenomenon in the Absaroka-Beartooth, as indicated by the extensive stands of lodgepole pine on Douglas-fir sites. Because of active fire suppression, the only major fires in recent decades were the Rock Creek-Hellroaring Lake fire of 1948 (5,000 acres) and the previously mentioned Horseshoe Basin fire of 1953 (1,200 acres) (11).



Fire suppression has had a marked effect on natural ecosystems. Natural succession has been hastened, the age structure of communities has changed, and forest litter has tended to accumulate. In many cases the result is stagnancy and a deterioration of wildlife habitat.

Biota

WILDLIFE AND FISHERIES

In most of the Beartooth, productivity is so low that wildlife populations cannot be supported. There are important exceptions: Bighorn sheep summer on the alpine plateaus and winter in small strategic areas in the valleys of the Stillwater River, East and West Rosebud Creeks, and Rock Creek. Mountain goats summer and winter on the plateaus from Rock Creek to East Rosebud Creek. The foothills, from West Rosebud Creek clockwise around the area to Gardiner, support dense mule deer populations. Small but important resident elk herds summer in the area and winter on key locations in Rock Creek, West Fork Rock Creek, and other valleys (11).

The Absaroka is more suitable than the Beartooth for diverse wildlife populations because of more moderate climate, higher productivity, and better-developed soils. In summer the southern Absaroka supports a dense elk population, part of the migratory northern Yellowstone herd. Numerous drainages on the western flank of the mountains provide key winter ranges for small resident herds. Mountain goats are plentiful in the Mt. Wallace-Crow Mountain-Pyramid area and occur also in the vicinity of Haystack Peak-Roundhead Butte.

The Beartooth is embellished with hundreds of alpine and subalpine lakes. Many of these lakes are sterile (with respect to fish) because of low nutrient concentrations and low oxygen content in winter. Others have been stocked with grayling and with cutthroat, golden, rainbow, and brook trout. Some of the lakes support productive fish populations. In others, problems arise from low productivity and/or heavy fishing pressure. The stream fishery in the Beartooth is minimal because of steep gradients, low temperatures, and low nutrient concentrations (11).

Unlike the Beartooth, the Absaroka has few lakes, but the stream fishery in the southern Absaroka is important. The water here is productive because of high nutrient concentrations (11). In Slough Creek, grazing by cattle, horses, and wildlife has adversely affected the fishery by reducing cover and causing localized flood damage.

A number of Absaroka-Beartooth animals were included in the Bureau of Sports Fisheries and Wildlife 1968 list of rare and endangered species (10). Among these are grizzly bear, prairie falcon, and Arctic grayling (rare); American peregrine falcon (endangered); pine marten, wolverine, Canada lynx, ferruginous hawk, and American osprey (status undetermined). Other animals found in low numbers in the area include the cougar, bald eagle, great gray owl, sandhill crane, and trumpeter swan. The wolf may be extinct here.

Whether some of these animals are indeed rare or endangered is a subject of controversy. Many, however, are specific in their needs for wild, undisturbed land. With current pressures for development of wildlands, it is evident that, at the very least, their habitat is endangered.

TIMBER

Logging has occurred on the fringes of the Absaroka-Beartooth, for example in the forks of Rock Creek, Red Lodge Creek, West Fork of the Stillwater River, Mill Creek, Bear Creek, and Palmer Creek. The major timber resource is located in Hellroaring, Buffalo Fork, and Slough Creeks. This resource has development constraints because of seasonal access, the Absaroka Primitive Area, steep slopes, soil instability, erosion potential, sensitive ecosystems, and long haul distances (11).

Spatial Relationships In The Human Environment

Land Ownership

Essentially all of the Absaroka-Beartooth area is within the boundaries of the Gallatin and Custer National Forests. Most of the land is therefore in public ownership; exceptions are a few homesteads and a number of mining claims in the mining districts listed previously. Within these forests are the aforementioned Absaroka Primitive Area and the Beartooth Primitive Area.

Transportation Systems

Transportation to the Absaroka-Beartooth is provided by a system of airports, railroads, and roads on the periphery. Within the area, transportation is by an extensive trail system and by graveled or unsurfaced roads in the lower portions of the major drainages (12).

The trail system was created partly by use, partly by construction efforts. Some of these trails are poorly located and designed in terms of slope, erosion, bog formation, and aesthetics.

Roaded drainages include Bear Creek, Emigrant Creek, Mill Creek, West Boulder River, Main Boulder River, East Boulder River, West Fork Stillwater River, Stillwater River, East and West Rosebud Creeks, Red Lodge Creek, West Fork Rock Creek, Rock Creek, and Clark Fork of the Yellowstone. Many of these roads have excessive grades and inadequate cross-drainage and have caused stream siltation and land instability.

A unique transportation feature, noted in the preceding Yellowstone Rockies perspective, is the Beartooth Highway (U. S. 212) which connects Red Lodge with Cooke City across an 11,000-foot pass on an alpine plateau.

Recreation

Outdoor recreation is a primary use of the Absaroka-Beartooth. In summer, camping, backpacking, horseback trips, motoring, hiking, fishing, climbing, boating, cycling, and picnicking are popular. Hunters use the area intensively in fall. Winter activities include downhill and cross-country skiing, ski mountaineering, and snowmobiling. Demands for all of these uses are increasing (12).

Wilderness

In accordance with the 1964 Wilderness Act, the Forest Service is studying the Absaroka-Beartooth to determine its suitability for inclusion in the National Wilderness Preservation System. Congress can ultimately preserve as wilderness none of the area or as much as about 900,000 acres.

Wilderness designation would, for the most part, preserve or improve the environmental quality discussed herein. A valuable, unique, and scarce wilderness resource would be provided for this and future generations of Americans in accordance with the letter and intent of the Wilderness Act (1).

Wilderness designation would place constraints on the development of such resources as minerals, water, and forage. Logging and motorized use would be prohibited. The need, value, and/or cost of development of these resources present a land management issue of major importance to the people of Montana and the nation.

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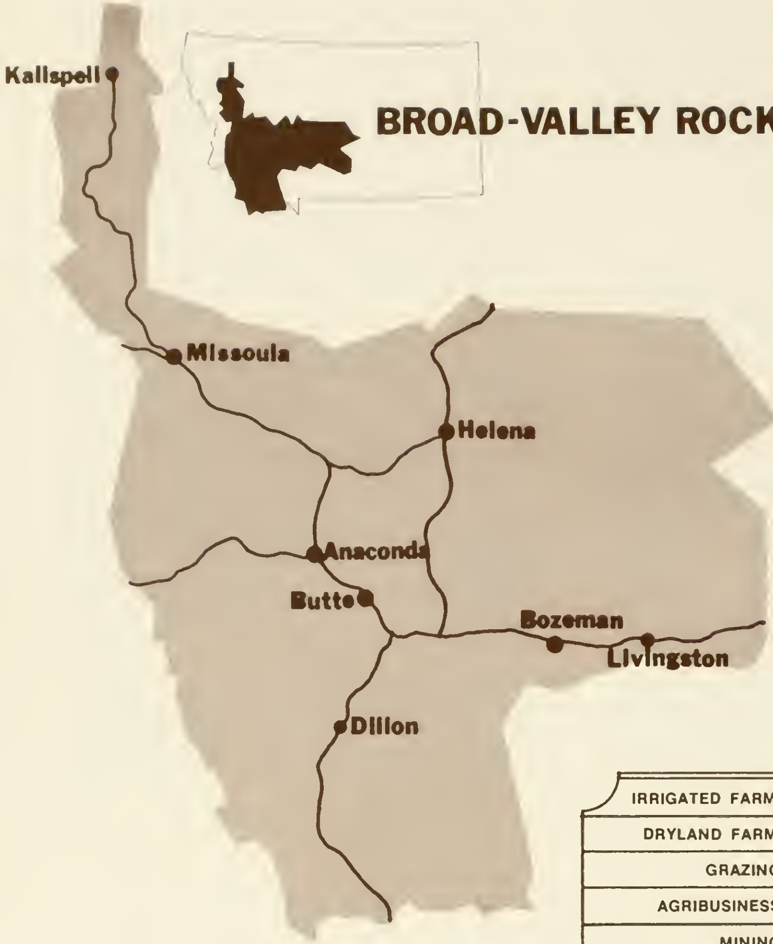
BROAD-VALLEY ROCKIES



ENVIRONMENTAL IMPACT MATRIX

ENVIRONMENTAL CLASSES

		WATER			BIOTA			
	AIR	SUBSURFACE	SURFACE	SOIL	VEGETATION	AQUATIC LIFE	WILDLIFE	ESTHETICS
IRRIGATED FARM.		○	●	○	○	●		
DRYLAND FARM.	○			○	○		○	
GRAZING			○	○	●	○	●	
AGRIBUSINESS	○		○			○		○
MINING	○		●	●	●	○	○	●
MIN. PROC.	●		●	○	●	●	●	●
LOGGING	●	○	○	●	●	○	○	●
WOOD PROD.	●	○	○					○
MANUFACTURING	○		○			○		○
RESIDENTIAL	○	○	●	●	●	●	○	●
TRANSPORTATION	○		○	●	●	○	○	●
COMMUN. & UTIL.				○	○			●
WATER STORAGE			●	○	○	●	○	○
RECREATION			○	●	●	○	○	●

○ MINOR
● MAJOR

Broad Valley Rockies

Environmental Perspective

In this region, the land opens out. the commanding vertical dimensions of the Columbia and Yellowstone Rockies relax into spaciousness. Dr. Crowley has noted "the panoramic views of mountain ranges across wide river valleys and undulating foothills." One of these valleys — the Missoula — typifies much of the Broad Valleys lowlands and was described by Lewis and Clark as "an extensive level plain and prarie, which on their lower parts are ornamented with long leaved pine and cottonwood, while the tops of the hills are covered with pine, larch, and fir" (3). The Missouri River is formed in the Broad Valley Rockies, and the explorers noted too "the dividing ridge" between its waters and those of the Columbia, the Continental Divide that winds across the region for nearly 200 miles. Everywhere in the Broad Valley Rockies, these mountains dividing the nation's waters and other ranges — the Crazies, the Bridgers, the Tobacco Roots, the Centennials, a multitude more — sharpen the distance with diamond-bright peaks and mark the horizons of western Montana's largest and most diversified region.

The Broad Valley Rockies is the historic cradle of Montana. As the first Montana frontier, it contains the state's oldest white settlements and first cattle ranch, its two territorial capitols, and the sites of most of the nineteenth-century mineral discoveries. This sector of western Montana, permanently settled while most areas east of the mountains were still held by the Indians, has been under the domain of white immigrants longer than any of the other environmental regions of the state.

Pioneers were drawn to the Broad Valley Rockies by its attractive combination of environmental features — mountains and valleys, timber, wildlife, water, and minerals. Most of the early immigrants were engaged in either mining (including, at that time, the supportive industry of logging) or ranching. The region became the industrial, cultural, and educational heartland of Montana, as it remains today. Several Broad Valley counties are among those that show continued population increases during the last decade; the region's average density is now about eight people per square mile. The major river valleys of the region form natural corridors for transportation and communication. Development has been moderate to heavy along these corridors and intensive at the arterial intersections. The restrictions imposed by topography have intensified many of the environmental conflicts ensuing from development.

Despite such development, the Broad Valleys retains many of its natural amenities, with numerous areas allocated for outdoor recreation or wildlife management. The region contains two designated wildernesses, the Anaconda-Pintlar and Gates of the Mountains, totaling 192,512 acres. The Forest Service may suggest seven roadless areas as candidates for inclusion in the National Wilderness Preservation System — Red Rocks, Italian Peak, West Big Hole, West Pintlar, Pioneers, Gates of the Mountains, and Upper Beaver. For one reason or another, thousands of additional acres of roadless wildland have not been officially considered for wilderness candidacy. The Bureau of Land Management administers two recently designated primitive areas in the region, the Humbug Spires near Divide, which encompasses 7,041 acres (22), and the Beartrap Canyon on the Madison River, comprising 3,639 acres (20).

The Forest Service maintains 71 campgrounds and 14 picnic grounds in the Broad Valley Rockies. These are distributed among the seven national forests found wholly or in part in the region. Federally administered historic and wildlife areas include the Big Hole National Battlefield near Wisdom, the National Bison Range near Moiese, and four wildlife refuges — Red Rock Lakes in the Centennial Valley, Pablo and Ninepipe in the Flathead, and Ravalli in the Bitterroot.

The Montana Fish and Game Commission controls 23 parks, monuments, and recreation areas in the Broad Valleys, including the Missouri River Headwaters State Monument, Lewis and Clark Cavern State Park, and several parks and recreation areas surrounding Flathead Lake. These lands total 8,830 acres. The Commission also administers 19 game management areas, totaling [illegible] acres.

Portions of six nationally renowned Class 1 "blue ribbon" trout streams — the Flathead, Missouri, Big Hole, Madison, and Yellowstone Rivers, and Rock Creek — traverse the region and offer 308 miles of superlative fishing. In addition are 178 miles of Class 2 water on 17 rivers and streams. Use of these and other streams as well as lakes and reservoirs is facilitated by 54 fishing access sites, totaling 7,312 acres, provided by the Fish and Game Commission.

A survey of deer and elk winter range conditions in the Broad Valley Rockies indicates that elk are faring much better than deer. The quality of elk range in the various hunting districts of the region, according to the 1972 season recommendations (12), varied from poor to excellent, with most of the ranges in fair to good condition and some restricted because of snow, livestock competition, or lack of suitable habitat. Deer ranges, on the other hand, were mostly in poor to very poor condition, with only two listed as fair, four good, and none in the excellent category. The poor quality of key forage browse is largely attributable to overuse, particularly on winter range.

Four years (1968-1971) of spring breeding-bird survey data for the Broad Valley Rockies from six routes indicate a fairly high and stable diversity in all censused areas (5,6). The four-year maximums in number of species per route ranged from 41 on the Elliston route to 60 on the Chestnut (near Bozeman). The four-year minimums ranged from 34 (Elliston) to 53 (Kalispell).

The region's concentration of recreational facilities and environmental amenities has drawn many people from across the country. The impact of their visits varies, but is ubiquitous. Extensive off-road use of four-wheel drives, motorcycles, and snowmobiles has become a serious problem in many locations. The litter discarded along the lakes, streams, and roads that traverse the Broad Valley Rockies has degraded the quality of the region and necessitated an expensive campaign of collection and cleanup.

Although recreation use has adversely affected environmental quality to a critical degree in localized instances, far more serious and widespread degradation has been caused by other human pressures on the region's resources. "My people's errors have become the features of my country," said Wendell Berry, a farmer, writer, and faculty member of the University of Kentucky:

> **What I am has been to a considerable extent determined by what my forefathers were, by how they chose to treat this place while they lived in it; the lives of most of them diminished it, and limited its possibilities and narrowed its future (2).**

This statement was never more applicable than in the Broad Valley Rockies. Extraction, often outright exploitation, of mineral reserves and other basic resources has been most intensive and prolonged in this region. Mining, especially hydraulic placer mining, disrupted or completely destroyed ecosystems in and along nearly all streams that bore evidence of valuable metals. Suits, both civil and criminal, filed by the federal government alleging "universal, flagrant and limitless timber depredations on the public domain," (23) marked one of the first battles in the long "War of the Copper Kings."

The Anaconda Copper Company alone contracted for 300,000 cords of wood in 1884 and was using 40,000 board feet of timber per day in the mines in 1888 (23). The beef market in the mining camps was also excellent, and the livestock industry grew rapidly. By 1880 overcrowded ranges had already become a problem in the western part of the Territory, and since that time Joseph K. Howard's description of the northern Great Plains has been applicable to much of the Broad Valleys:

> **Seldom now — only in an exceptionally wet spring — does this grass grow tall enough to "roll in the wind like the sea" as the first white men saw it... Now, save in especially favored seasons, it is sick: gray, scrawny, really "short" — a few inches tall at its best, growing sparsely in dun colored clay fields or powdery sand, struggling to hold its ground against the Russian thistle . . . (11).**

Multiple exploitation of multiple resources, plus accessory residential and service developments, have combined to create severe impacts on the region's environmental quality — air, water, and land. Perhaps most significant at present is the effect on air and thereby on soil, water, and biota. Air quality in the Broad Valley Rockies is generally poorer than that of the rest of the state. The concentration of urban industrial development, coupled with topographic barriers to ventilation, has led to very serious air pollution problems in a number of locations. Atmospheric quality data indicate that when wind speeds are equal to or less than seven miles per hour conditions exist that are conducive to atmospheric contamination. This situation is common throughout the Broad Valley region (10).

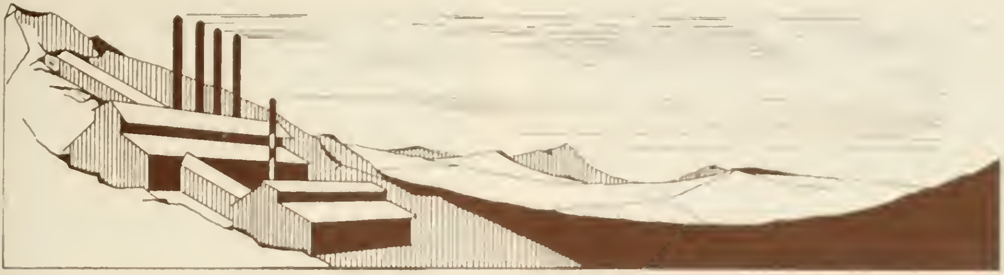
The principal sources of air-borne pollution are centered around four major areas — Anaconda-Butte, Kalsipell-Whitefish-Columbia Falls, Helena-East Helena, and Missoula. In addition to these, a number of isolated points suffer local contamination, for example Garrison, Trident, and Belgrade.

In the Anaconda-Butte area, as elsewhere in the Broad Valleys, mineral processing has played a major role in air pollution problems since early days. The Anaconda Company smelter at Anaconda began operation in 1902. By February of the following year,

> **. . . many of the farmers of Deer Lodge Valley complained that such large quantities of sulfur and arsenic were being discharged from the several smoke stacks that the crops and livestock in the valley were being poisoned and injuriously affected with serious financial loss to the owners (24).**

In 1905 farmers again alleged damage to livestock and crops and asked for a permanent injunction against operation of the smelter. Five years later, an independent team evaluating timber losses in the Anaconda vicinity reported:

> **Passing over the Continental Divide . . . one is struck by the great change which has taken place in three years. What is now a Ranger's cabin in a rusty and dying forest was then a roadhouse surrounded by very good-looking timber... The few living trees then remaining (on the hill south of the smelter) are now dead, and the turf on the slopes has been killed long enough for increased wash to be noticeable (18).**



Significant levels of air contamination are still associated with this facility and with mining and milling operations in Butte.

> **In and near the Berkeley Pit, blasting and activities associated with ore handling and transport make a steady contribution to dust in the area . . . Enforcement of Regulation 90-005, suppression of airborne particulate matter, will bring about a reduction of dust from the Berkeley Pit. Removal of dirt piles and debris near the pit, plus good housekeeping by the city of Butte and application of the latest street-dust suppression techniques will bring the Butte "hot spot" into compliance with the air quality standards (16).**

In a study of air pollution in the Deer Lodge Valley between 1965 and 1966, the Montana Department of Health found excessive levels of total suspended particulate in Garrison, Deer Lodge, and Anaconda (13). The annual averages measured were in excess of the secondary federal standards by 49, 10, and 29 ug/M³ (micrograms per cubic meter) of air respectively. Recent figures show the need for a 25-percent reduction in suspended particulate in the Anaconda vicinity. Evidence indicates that readings would be much higher if the samples were located nearer the Anaconda smelter's tailings pile and settling ponds. Control programs for both of these sources are under way. The same area shows elevated amounts of arsenic and lead and excessive amounts of sulfur dioxide near Anaconda. Recent sampling indicates the need for a 92-percent reduction in sulfur dioxide if compliance with the 24-hour maximum mean standard is to be achieved (16).

In the Flathead Valley air quality has shown an alarming decline in the past several years according to a health department study from November, 1968 to August, 1970 (14). This has been attributed partly to significant rises in population and motor vehicle registration in Lake and Flathead Counties and partly to continued wood products manufacturing and increased mineral processing.

Suspended particulate levels have increased 31 percent and 25 percent respectively in Columbia Falls and Kalispell from the 1963-1964 to the 1969-1970 sampling year. The 1969-1970 annual mean concentrations of 151 ug/M³ and 87 ug/M³ suspended particulate for Columbia Falls and Kalispell were well above the federal secondary standard of 60 ug/M³. During the same period sulfur dioxide concentrations increased 86 percent in Columbia Falls and 80 percent in Kalispell. Insufficient data were available to demonstrate the suspected increases in other pollutants measured.

In general the major measured air pollutants of the Flathead Valley are fluoride, suspended particulate, and dustfall. The health department study (14) showed ambient fluoride levels grossly in excess of the state standard in the immediate area of the Anaconda aluminum plant in Columbia Falls, decreasing to occasionally excessive amounts at the southern extremity of the study area. Effects of these fluoride emissions on Glacier National Park have been mentioned in the Columbia Rockies perspective. A recent field analysis by the Forest Service as a followup to its 1971 report indicates that emissions may have been reduced by as much as 40 percent (9). However "the reduction to the 2,500 pounds per day claimed by the company has not been sufficient . . . to effect a cessation of fluoride accumulation and damage to the flora and fauna of the three zones in Glacier National Park studied in 1971" (9).

In these zones — Headquarters Hills, Belton Hills, and Apgar Ridge — analysis of 1971 pine needles shows increases in fluoride accumulations ranging from 20 percent to 128 percent between June and November of 1971 (9).

> **The average flouride accumulation in all years of coniferous foliage collected in Glacier National Park in 1970 and 1971 demonstrated an increase during this 7 to 12 month interval which is dramatically higher than accumulations found in similar foliage from control areas. The increase in fluoride accumulation in juvenile animals collected in the Park adequately demonstrates that the fluoride accumulation in these young animals is primarily derived from the fluoride polluted vegetation they are consuming and not from the parents (9).**

Comparable conditions exist outside the park on thousands of acres of national forest and other lands within the [illegible] Valley and Columbia Rockies regions.

Dustfall values for Columbia Falls and Kalispell, 30.4 and 14.3 tons/mi²/mo (tons per square mile per month) respectively, were higher than values recorded for Los

Angeles and New York City. The most significant sources of suspended particulate and dustfall are paved and unpaved streets and open burning, with a significant portion of the suspended particulate attributable to emissions of waste burners of the wood products industry.

In the Helena Valley, according to data recently published by the Environmental Protection Agency,

> **Atmospheric concentrations of sulfur dioxide . . . exceed Montana air quality standards and levels reported in Federal criteria to be associated with deleterious effects on human health, vegetation, and materials (7).**

Industrial smelting operations of the Anaconda Company and American Smelting and Refining Company in East Helena are the responsible sources.

Soil and water in the Helena Valley are also contaminated with heavy metals from the East Helena smelting companies. The water, although containing arsenic, cadmium, lead, zinc, iron, and manganese, does not exceed the mandatory limits of the U. S. Public Health Service drinking water standards (7). Arsenic, cadmium, and lead, emitted as air pollutants from the smelters, settle and accumulate in soil and on vegetation to levels exceeding those that are toxic to grazing animals. Evidence also indicates that subclinical effects could be occurring in humans (7).

In the Missoula area five major sources — Evans Products Company, Hoerner-Waldorf Corporation, Intermountain Lumber Company, Van Evan Company, and the Forest Service — are defined as emitting 100 tons or more of particulate per year (17). Data collected by the Missoula County Health Department at the county courthouse in 1970 revealed the suspended particulate level to be in excess of the maximum permissible annual mean concentration (secondary federal standard) by 31 ug/M^3 of air (17). Particulate concentrations measured in 1971 were below the federal secondary standard, but measurements were taken at stations other than the one sampled in 1970 and sampling was less exhaustive. Nevertheless, a considerable reduction in woodwaste burning has been achieved, and air quality in the Missoula area has improved in the past year (15).

The Broad Valley Rockies as a whole currently has about 80 violations of state air quality regulations, concentrated in the wood products industry and commercial retail enterprises (15). Progress has been made in terms of municipal open-burning dumps, which have been largely replaced in recent years by sanitary landfill disposal sites. There are now 22 proper disposal sites in the region, including those serving Anaconda, Bozeman, Butte, Dillon, Hamilton, Helena, Kalispell, Livingston, Missoula, and Whitefish. Four communities proposed landfill conversions by July 1, 1972 while two others, in the Helena Valley, have no burning but infrequent covering.

Montanans are largely dependent upon the automobile as the primary means of travel. Automobile emissions are not now noted as one of Montana's serious air quality problems, but if population growth concurrent with an even more rapid increase in the number of automobiles continues, the situation could grow more severe in the inversion basins of the Broad Valleys. Emission controls imposed by the federal government may prevent development of serious problems.

Two national forests, the Deer Lodge and the Beaverhead, are located almost entirely within the Broad Valley Rockies. Slash burning on these representative forests was practiced for a total of 55 days (30 and 25 days respectively) during 1971. This is contrasted to 80 days on the Flathead and Kootenai forests in the Columbia Rockies and 19 days on the Gallatin and Custer forests in the Yellowstone Rockies, indicative of timber harvest and management variations in the different regions.

Logging, although less intense in the Broad Valley Rockies than in the Columbia Rockies, has significantly altered the landscape and its biotic communities and will probably continue to do so. The discussion of logging in the contributed paper of the University of Montana School of Forestry applies to all timber harvest areas of Monana, including the Broad Valleys. The impacts on soil, wildlife, vegetation, and watershed, in this region as elsewhere, vary in degree with each site but are basically similar. Such areas as Miller Creek and Schwartz Creek are examples of the ecological disruption that can be caused by logging.

As indicated earlier, livestock grazing in the latter part of the nineteenth century significantly affected the character and quality of the Broad Valleys landscape, its fauna and its flora. The first domestic cattle to graze Montana grasses were stray steers picked up along the emigrant trails to the south and brought to the Beaverhead and Deer Lodge Valleys to be fattened for resale along the same trails. Many huge livestock ranches were subsequently established in the Broad Valleys. Irrigated farming and ranching came later and are the economic mainstay for much of the region today.

Numerous impacts are associated with these enterprises. The most significant and the best understood, is the dewatering of many streams in the region, leaving but a surface trickle during the dry summer period. The most notable of these are the West Gallatin, Beaverhead, and Bitterroot Rivers.

Many miles of streams in the region's valleys and adjoining mountains have undergone serious ecologic disruption through partial or complete diversion of streams and rivers. Excessive irrigation and runoff have resulted in nitrate-nitrogen loss in some soils and nitrate contamination of groundwaters, with the return flows carrying soil particles that may transport additional absorbed nutrients and pesticides into streams and lakes.

The U. S. Geological Survey maintains 12 monitoring stations for water temperature, sediment, and chemical quality on Flathead Lake and on the Clark Fork, Flathead, Bitterroot, Blackfoot, Beaverhead, Jefferson, Missouri, and Yellowstone Rivers. Data for 1970 indicate water in the Clark Fork River at Deer Lodge had unusually high concentrations of total and fecal coliforms (up to 1,400 and 840 colonies per 100 milliliters respectively), plus dissolved copper, zinc, and other heavy metals (22).

1970 figures indicate that the Clark Fork below the Anaconda settling ponds ran red at least once nearly each month. Red water discharges from the settling ponds were documented on October 6 and October 21 at Warm Springs, and on October 22 a yellowish discharge was noticed at the same location. On August 11, red water was observed and documented at Deer Lodge. Iron and copper pollution in these cases usually came in intermittent surges (8). The reasons for these surges have been given as wind action, high water, or pH manipulations due to quantities of lime added. When impounded water becomes acidic or weakly alkaline, copper will dissolve and wash from the pond into the Clark Fork. The amount dissolved depends upon the degree of acidity (17).

In a report filed March 3, 1972, the Department of Health and Environmental Sciences described an episode on February 29 and March 1, and stated that "The spill of untreated water on January 2, 1972, and the current spill have probably seriously impaired the recovery of aquatic fauna in the Clark Fork River between Warm Springs and Garrison" (25).

The health department has identified five stream reaches within the Broad Valley Rockies that are not in compliance with Montana's water quality criteria. An estimated 220 stream miles fall into this category in the region, out of a total of 550 stream miles so classified in the state. The reaches and the reasons for noncompliance are as follows. Ashley Creek below Kalispell — coliform limits exceeded; Spring Creek below Ronan — dissolved oxygen too low; Madison River entering Montana — arsenic limits exceeded; Clark Fork of the Columbia below Garrison — sulfates exceeded; Clark Fork of the Columbia below Warm Springs — zinc, copper, and iron exceeded.

The Seattle office of the Environmental Protection Agency has identified four pollution zones in the Broad Valley Rockies (out of 10 in the state) having significant water quality problems. They were compiled in the agency's "pollution priority index" for Montana. The zones and their rank of priority in the state are Silver Bow - Deer Lodge Counties, one; Flathead Lake, five; Missoula, nine; and Livingston, 10.

Many of the 13 rivers and streams inventoried in the 1963 Montana Fish and Game Commission study of channel changes in Montana streams (1) are in the Broad Valley Rockies. At the time of the study, percentages of stream miles altered ranged from 14 to 63 for the nine streams within the region. Because channel changes are detrimental to aquatic environments, the Department of Fish and Game should update the 1963 report and survey alterations on important waters not included in the original study.

Many lakes and reservoirs in the Broad Valley Rockies are threatened by eutrophication. The most important are Flathead Lake, Canyon Ferry Reservoir, and Georgetown Lake, which are discussed in the paper on eutrophication following this section. Many smaller pothole lakes in the Flathead Valley are ringed with homesites with septic tanks and are immediately threatened by algal blooms and related problems.

According to health department statistics the Broad Valley Rockies has the largest portion of the sewered population of Montana — 181,201 people or 42 percent of the state's total. Before release into surface waters, 60 percent of the sewage receives secondary treatment and the remaining 40 percent receives primary treatment, all by mechanical clarification. Only in this region is the activated sludge form of secondary treatment in extensive use, serving 62,896 people, mostly in Butte and Bozeman. The Bozeman plant is not fully equipped, however, and about half of the primary sewage bypasses the secondary treatment process and flows into the East Gallatin River. Almost half of the secondary treatment in the region is provided by lagoons, including one serving the city of Whitefish.

Projected secondary treatment plants in Hamilton, Helena, Kalispell, and Missoula by 1974 and in Livingston by 1977 will greatly reduce the biochemical oxygen demands on surface waters receiving these discharges. Nutrients will not be greatly reduced, however, and will continue to cause problems with nuisance aquatic plants, particularly in Ashley Creek and in Flathead Lake below the Kalispell effluent.

Ninety-five percent of the public drinking water supplies in the Broad Valley Rockies were satisfactory in 1971 and did not exceed allowable coliform numbers as determined by the state health department. This is about the same as the average figure for the entire state. Major communities with unsatisfactory supplies were Columbia Falls and East Helena.

Many local water quality studies have been conducted throughout the region in recent years by various state and federal agencies and educational institutions. One of the more recent and intensive studies was on Rock Creek (Columbia drainage) by the University of Oklahoma School of Civil Engineering and Environmental Science (19). Two not so very profound conclusions were derived from the data, namely that water in Rock Creek and the tributaries studied is excellent and conforms to Montana water quality criteria, and that Rock Creek and its tributaries have excellent water quality characteristics that are well within the range for wild trout production and survival.

Additional sources of information on Montana's surface water quality, particularly that of the Broad Valley Rockies, include graduate theses from the state's two universities, and, for Flathead Lake, the University of Utah. Another source is the national computerized data retrieval system for water quality known as STORET. This system has been fed data from all federally operated water quality sampling stations in Montana, printouts are available from the Region VIII office of the Environmental Protection Agency in Denver. The state health department has recently initiated a water quality monitoring program, and this data will be added to the STORET system as it is obtained.

Transportation systems, both auto and rail, and utility transmission lines have had major environmental impacts on many of the region's valleys. Aesthetic degradation from these sources is extreme. Although the Stream Preservation Act has helped to reduce the damages of highway construction to streams, parallel alignments of highways, frontage roads, railroads, and utility corridors in many of the primary valleys have resulted in substantial land use tradeoffs, which have significantly reduced agricultural land and interfered with other uses. The interstate highway system alone has preempted approximately 14,000 acres in the Broad Valleys.

Environmental consequences of population growth in the region, as reflected in residential and other developmental activities, continue a story that began long ago. Settlers, with their mining, agricultural, and logging industries came early to the Broad Valley Rockies of Montana. The scars and leftovers of their earlyday toils are everywhere — on the mountain sides, in the gulches, on the valley floors — and the toils of their modern-day counterparts repeat and magnify past abuse. In isolated areas of the region, nature in its resiliency has erased some of the outrages committed against it. Mountains still shine, forests stand ancient and quiet, streambanks burgeon with life, and Flathead Lake lies in dreamlike beauty beneath the towering Missions; the Anaconda-Pintlar and Gates of the Mountains Wildernesses, the unroaded reaches of public land whose future is not yet known, are nearly as they were before white men came to the Broad Valleys.

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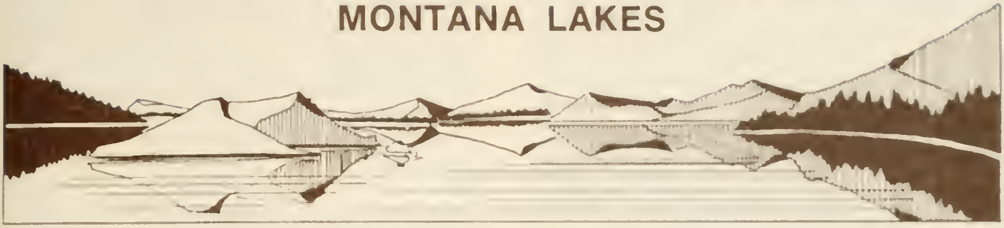
EUTROPHICATION IN THREE WESTERN MONTANA LAKES



by
Loren L. Bahls

Introduction

Water is one of the most valued yet probably the most abused of the Broad Valley Rockies' natural assets. Much of it originates in the high mountain basins of the adjacent Yellowstone and Columbia Rockies, where consumptive use and unnatural pollution are limited. Once the rivers and streams reach the more populous lowlands of the Broad Valley Rockies they are subjected to a variety of mistreatments: from complete dewatering for irrigation to inundation for flood control, irrigation water storage, power generation, and recreation, from heavy-metals contamination from mine spoils to municipal sewage pollution and unnatural siltation caused by poor watershed management. Any one of these uses or misuses of water may have far-reaching adverse effects on the natural, highly integrated community of aquatic organisms, all the way up the food chain from the microscopic alga to the trophy trout. Fortunately, the upper reaches of most flowing waters in the Broad Valley Rockies have retained their pristine beauty and quality.

Rivers have an indefinite capacity for renewal, for purging foreign substances from their systems, and for recovering health that has been lost. They are virtually timeless, aging only in the geologic sense as they wear away their beds and carry their substrate, pulverized to fine particles, incessantly downstream, thereby imperceptibly reducing their gradients. Lakes, however, are not nearly so resilient and long-lasting. They are repositories for innumerable natural and unnatural pollutants, including silt and nutrient chemicals carried by and flushed from rivers and streams above.

Natural silts, settling and accumulating on a lake bed, reduce the depth and volume of water and shorten the physical life of the lake. Natural nutrient chemicals, leached from the watershed, enhance the growth of aquatic plants. This, along with reduced depth, eventually results in seasonal oxygen depletion, stagnation, and fish kill, terminating the esthetic, recreational, and preferred biological life of the lake. There is no chance for recovery; in most cases the combined process, eutrophication, is irreversible.

Accordingly, lifespans of lakes are measured in centuries or, in the case of some man-made reservoirs, in decades, rather than the millennia through which rivers persist. Lakes are finite and transitory when measured on the geologic time scale.

Flathead, Canyon Ferry, And Georgetown

The Broad Valley Rockies has a number of lakes and reservoirs. The foremost of these, Flathead Lake, is the largest natural freshwater lake in the United States west of the Mississippi River and is in a class by itself in Montana and the nation as a recreational water resource. Another, Canyon Ferry, is the highest major mainstem impoundment on the Missouri River and is also a significant recreational resource for Montanans. Georgetown Lake, a small reservoir formed in 1894 to supply water for mineral processing at Phillipsburg and Anaconda, has long been known for its productive sport fishery.

These three highly valued waters are at various stages of eutrophication, not just the natural form discussed above but the accelerated form, called cultural eutrophication, resulting from human activity. Cultural eutrophication speeds up the natural aging process of a lake and shortens its useful lifespan. The manner of aging is much the same as the natural process, only faster. The primary causative agents, silt and nutrients, are again the same, but greatly magnified by human impacts on the watershed. Geologically speaking, the already finite lake, through cultural eutrophication, becomes ephemeral.

Flathead, the healthiest of the three lakes mentioned and by far the deepest, is only in the early stages of the eutrophication process. Although it is receiving nutrients and silt at an accelerating rate, the overall chemical water quality has not changed considerably since limnological studies in the 1920's (3,4). Sources of pollutants include feedlots and municipal sewage effluents in the drainage above the lake as well as irrigation return flows and probable contamination from individual septic tanks. Kalispell sewage is discharged into the lake via Ashley Creek and the Flathead River. It now receives only primary treatment, but secondary treatment is expected by 1974. Bigfork sewage receives secondary treatment and is discharged directly into the lake. It should be noted, however, that secondary treatment does not greatly reduce the concentrations of nutrients that stimulate algal growth, which still find their way into the lake. Waste disposal problems in the Whitefish area, caused by inadequate treatment facilities and rapidly expanding recreational and second-home developments, also add nutrients to this aquatic system. In addition, fluctuating flows in the Flathead River, caused by regulation at Hungry Horse Dam, periodically flush nutrients and vegetation from lowland agricultural areas and river backwaters into the lake.

On Flathead itself, numerous other problems are causing consternation to those who wish to see the lake remain in its present condition. A 1970 University of Utah graduate thesis (1) reported that seepage from septic tanks along the shoreline contributed significant numbers of coliform bacteria to the water, but that the main body of the lake was free from fecal coliforms and often free from all coliform types. Dredging and filling operations to create more shoreline are encroaching upon the lake and causing local turbidity problems. The Army Corps of Engineers does not consider itself responsible for issuing permits for these operations because, according to the Corps, Flathead Lake is not a navigable waterway. Pesticides applied to the numerous cherry orchards around the lake are another possible pollutant source, as is sewage from overused recreation areas, particularly Yellow Bay State Park. In context with recreational pollution, it is unlawful for boaters to discharge untreated wastes directly into the lake.

On Canyon Ferry Reservoir, algal blooms have been a common occurrence since shortly after impoundment. Reservoirs often become highly productive because inundation encompasses former floodplains rich in nutrients, which are leached into the impounded water and support vigorous populations of planktonic algae. The initial cause of cultural eutrophication in Canyon Ferry was therefore the construction of the dam. It is still the primary cause; the Missouri River's high natural fertility has maintained the problem to this day. According to early and recent findings from Montana State University research, the reservoir's trophic status has changed very little since impoundment (5,6). Nutrients have not been accumulating because they are regularly removed by deep water withdrawal; in fact, more nutrients are leaving the reservoir than enter at Townsend.

The only major source of pollutants upstream from the reservoir is the outfall of the Bozeman wastewater treatment plant into the East Gallatin River. Its influence is dissipated, however, by the time the water reaches Toston, some 12 miles above the reservoir. The mud flats at the upper end of the reservoir are sites of nutrient recycling but these will be eliminated as the area is reclaimed for waterfowl habitat under a project recently initiated by the Bureau of Reclamation. Montana State University scientists do not believe that agricultural activity in the Townsend Valley is a cause of eutrophication in the reservoir.

The eutrophication problem in Georgetown Lake is due primarily to the extreme shallowness of the water, which allows proliferation of rooted aquatic plants. More than 90 percent of the bottom area of the lake supports such growth. Because the volume of the lake is small in proportion to its total area, very little dissolved oxygen can be carried through the winter months. When ice and snow cover the lake many plants die for want of sunlight and in the decay process use up much of the limited store of oxygen, thereby causing winterkills of fish. This happened during the winter of 1936-1937 when the lake was drawn down nearly nine feet and could happen again any year that the water level is lowered.

Test conducted by the Environmental Protection Agency during the winter of 1970-1971 showed that the lake below 15 feet was devoid of oxygen. The same situation prevailed in 1963 when the Montana Department of Fish and Game attempted to restore oxygen to the lower levels by aeration.

Georgetown Lake's chronic eutrophication problem is apparently aggravated by improperly designed septic facilities of lakeshore residences, pushing of fill into the lake to extend cabin sites, bank erosion accelerated by waves from power boats, and use of the watershed for logging and grazing (2).

Owing to its shallowness and fertility, Georgetown ranks as one of the most productive and most heavily fished lakes in Montana, but for these same reasons it is rapidly reverting to the wet meadow it was back in 1893.

Proposal For Mitigation

To slow the rate of degradation and to prolong the lives of these lakes as well as others in Montana subject to cultural eutrophication, the first priority is to reduce the amount of nutrients and suspended materials entering the lakes from shoreline sources and from the watersheds above. Other methods have been proposed for rejuvenating eutrophic lakes, such as dredging and removing bottom sediments, aeration, and flushing with low-nutrient water, but these methods are costly, and for larger lakes, impractical.

Any significant evil resulting from man-accelerated eutrophication lies in condoning or permitting avoidable but irreversible foreclosure of future options for public use of our aquatic resources.

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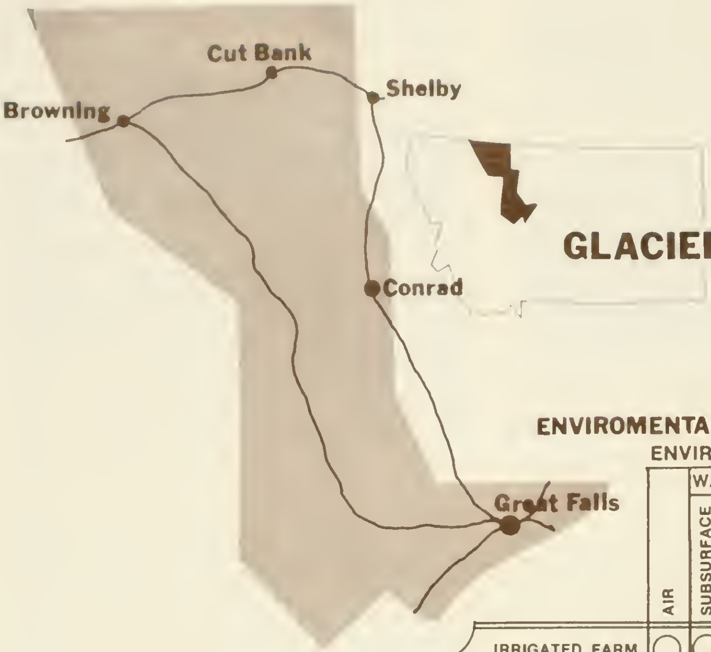
GLACIER FORELAND



ENVIROMENTAL IMPACT MATRIX

ENVIRONMENTAL CLASSES

		WATER			BIOTA			
	AIR	SUBSURFACE	SURFACE	SOIL	VEGETATION	AQUATIC LIFE	WILDLIFE	ESTHETICS
IRRIGATED FARM.	○	○	●	●	●	○	○	
DRYLAND FARM.	○	●	●	●	●		○	
GRAZING			○	●	●	○	○	
AGRIBUSINESS	○		○	○	○			○
MINING			○	○	○			○
MIN. PROC.	○		○					○
PETROL. PROD.		○	○	○	○			○
PETROL. REF.	○		○					○
MANUFACTURING				○	○			○
RESIDENTIAL	○	○	●	●	●	○	○	●
TRANSPORTATION	○			○	○		○	○
COMMUN. & UTIL.				○	○			○
WATER STORAGE			○					○
RECREATION			○	○	○	○	○	○

○ MINOR
● MAJOR

Glacier Foreland

Environmental Perspective

Great Plains Montana is A. B. Guthrie country. Here, in the northernmost of the Rocky Mountain Foreland subregions, in the lap of the great barrier range, is the Teton River landscape where Boone Caudill, Guthrie's trapper of the 1830's, could see

> The mountains lifted blue in the west, cutting sharp into the quiet sky. High and far in them lay patches of snow. He could see the mountain like an ear and the notch by its side that the Teton ran out of, and southward he could see the canyons of the Medicine with a high reef of rock on one side and a saw-toothed mountain on the other. Between the two rivers were smaller canyons made by streams that maybe the white man hadn't put a name to yet. None of them could be as pretty as the Teton winding, busy but not hurried, with a mind and time to have a look at things as it went along. Clumps of cottonwood grew on its banks, and chokecherry and serviceberry bushes and wild rose and red willow that the Indians mixed with tobacco. No place could be prettier than this valley, with two buttes rising to the south and the tan hills ridged wide on the sides, and cottonwood and black birch and sagebrush growing, and elk and deer about and buffalo coming down from the benches to drink. It was a place a man could spend his whole life in and never wish for better (3).

The dramatic beauty of the Glacier Foreland is keyed by its "mountains lifted blue in the west" — the ramparts of Glacier National Park and the Bob Marshall Wilderness — and by its predominantly glacial topography. Three lobes of continental ice extended short distances into the northern part of the subregion leaving a low rolling mantle of unconsolidated till and several small pothole lakes. The ice sheet also penetrated the southeastern boundary of Glacier County and left a hummocky topography that grades westward into ridges of till. The same eastern ice lobe is believed to have blocked major drainages, forming a Pleistocene lake in the vicinity of Cut Bank. Gravel-capped plateaus or benches, probably formed from pre-Wisconsin glacial outwash, are prevalent throughout the northern part of the subregion and stand 400 to 600 feet above surrounding streams.

The Glacier Foreland has probably the strongest and most persistent "chinook" wind on the North American continent. This feature of the subregion, like its landscape, is best described by Guthrie:

> The wind was warm, coming over the mountains, and notionable. Sometimes it cried shrill and wintry in the branches of the trees and then it would ease up and be no more than a whisper that the ear wouldn't catch unless it listened . . . The wind blew most of the time in this country, squeezing out of the canyons and sweeping on to the high plains, until a man got so used to it he hardly paid it any mind, except sometimes at night when he'd wake up and hear the wild, sad sound of it and hunch down farther in his blanket and buffalo robe, feeling safe, somehow, and good (3).

Following the frequent winter invasions of cold arctic air, the chinook usually starts to blow in 36 to 48 hours and often raises the temperature from well below zero to more than 32° F. in a very few hours. It often reaches speeds of 60 to 70 miles an hour, occasionally gusting to 100 mph. Because of the wind, the subregion's low temperature extremes have not been as cold as one might expect, and exceedingly hot summer weather is rare.

Recreational facilities within the Glacier Foreland are limited because it contains no national forest land, no parks or monuments, and a very few roadside campsites. However, its western border is contiguous not only to the Bob Marshall Wilderness and Glacier National Park but to many popular national forest recreation developments that are also immediately inside the Continental Rockies. Because of this proximity, the subregion's access routes and communities serving recreational visitors are extremely important for both user accommodations and economic returns. Also, the esthetic amenities of the Glacier Foreland itself — its grassy, aspen-dotted foothills against the mountain backdrop, its attractive rivers and potholes, its outstanding wildlife areas — are an open space resource of unusual distinction. Freezeout Lake game management area in Teton County is an 11,000-acre refuge that serves as a major stopping point for ducks and geese in the Central Flyway. The Sun River game range, purchased in 1948 by the Montana Fish and Game Commission, is an essential winter range for the Sun River elk herd.

Competition with other land uses has restricted wildlife habitat in the Glacier Foreland. Most of the subregion is not good deer range, although whitetails are plentiful along some of the heavily wooded river and creek bottoms, particularly in the Sun River drainage. Browse conditions have been poor the last few years. A number of transects taken west of Conrad indicate a drastic decline in the number of live juniper branches, a primary food source for deer. The drop from 73 to 33 twigs per 100 plants near Choteau during the winter of 1973 further suggests decadent browse conditions (4). Breeding bird survey data collected over the last four years on a route east of St. Mary indicate a consistent and reasonably healthy avian diversity, varying from a minimum of 27 species in 1969 to a maximum of 35 in 1970 (2). This area was also home for many species that have been forced elsewhere (wolf, grizzly, and elk) or eliminated (bison), or whose numbers have been seriously reduced. Rare and endangered species native to the subregion include the peregrine falcon, prairie falcon, and mountain plover, the black footed ferret and northern kit fox are probably extinct (8).

The comparatively (to other regions) high concentration of people, recent development of a great variety of off-road vehicles, and terrain that generally allows extensive use of such vehicles have disrupted soil and vegetation in some parts of the Glacier Foreland. Friction between landowners and users of these machines will probably end in limiting recreational vehicles to certain roads.

Snowmobile use has increased tremendously in the last five years and in some locations has affected soil, vegetation, and wildlife. The Glacier Foreland receives a moderate amount of snowmobiling pressure from the Great Falls metropolitan area. Brittle saplings hit by snow machines are often killed or deformed, and evidence indicates that heavy use in an area can increase the rate of soil erosion and reduce the yield of forage crops. In winter few if any animals can equal the speed or maneuverability of these machines, and unfortunately some enthusiasts chase animals, often to the point of exhaustion. Perhaps the single most irritating aspect of snowmobile operation is the unmuffled whine of two-cycle engines in an otherwise tranquil winter setting.

Both natural and cultural features change sharply as one moves from the western to the eastern portion of the Glacier Foreland — from the quiet, sparsely settled, rural landscape beneath the mountains to the open plains and, at the southeast terminus of the region, the urban complex of Great Falls. This city, containing 70 percent of the people in the Glacier Foreland, gives the total subregion a population density of 15 persons per square mile. It also gives the subregion its only recorded air quality problems, and these are insignificant relative to those of western Montana.

Although Great Falls is classified by the Department of Health and Environmental Sciences as one of the potential "hot spots" in the state, it was not listed as an area requiring substantial improvement in air quality in 1971. Most of the more than 70 violations in 1970 were unapproved incinerators, but airborne contaminants are also derived from asphalt plants, junk yards, grain elevators, an oil refinery, and the Anaconda Company zinc smelter. The zinc operation has since been shut down for economic reasons. Great Falls currently requires no reduction in particulate emissions to meet the national secondary standard of 60 $\mu g/m^3$ (micrograms per cubic meter) annual geometric mean, and sulfur dioxide levels are within the standard of .02 ppm (parts per million) annual arithmetic mean (5). Strong persistent winds spare Great Falls from air pollution problems characteristic of other large Montana cities, particularly those in the Broad Valley Rockies. Inversions occur in Great Falls, but they are generally of short duration because of atmospheric turbulence and mixing and the frequency of chinook winds during the winter months.

In the Glacier Foreland, as in the rest of the Rocky Mountain Foreland, agriculture is the primary human activity. Cattle ranching is dominant along the mountain front and in the foothills in the western part of the subregion, dryland and irrigated farming prevail in the eastern and central portions. As shown on the matrix, these agricultural operations produce major impacts on water, soil, and vegetation.

Five large rivers — the Missouri, Milk, Teton, Sun, and Marias — flow through the Glacier Foreland and provide water for more than 275,000 acres of irrigated farming. Irrigation return water from the Greenfields Bench irrigation project has accelerated the rate of erosion and increased the sediment load in lower Muddy Creek in Cascade County. Turbidity in the Sun River below its confluence with Muddy Creek exceeds the limits of Montana's water quality criteria. Irrigation on the Seville Bench in Glacier County has raised the local water table and necessitated excavation of open-ditch drains. Topsoil erosion by water has been classified as severe throughout the subregion (7).

Livestock ranching and dryland farming have also caused some serious conservation problems in the Glacier Foreland. Approximately 1.5 million acres are devoted to grazing, 65 percent of which need protection to allow recovery of the range and pasture. The subregion also contains about 1.2 million acres of land in tillage rotation, 60 percent of which is in need of strip-cropping, terracing, or diversions to control wind and water erosion (9). Wind erosion problems have been classified as moderately severe in this subregion (7). Soil and subsurface geology, coupled with current farming techniques, have resulted in a substantial loss of productive land to the process of saline seep (see Sweetgrass Plains).

Groundwater is of inconsistent quality and used for a variety of purposes throughout the subregion, including domestic and livestock supplies, secondary recovery of oil, small-scale irrigation, and cooling and processing in petroleum refineries. Industrial users have appropriated water from the Madison and Virgelle Formations and lowered the water level of shallow domestic wells in some parts of Glacier County. Although groundwater quality varies, it is generally less desirable than surface water as a municipal supply. Chemically unsuitable groundwater near Power and Ledger require that the residents of these towns haul their domestic water. The subregion's drinking water shows few signs of biological contamination, however, and no community water supplies, ground or surface, have coliform counts high enough to be considered unsatisfactory.

Several sewage problems exist in the Glacier Foreland. Only 27 percent of the population is served by secondary wastewater treatment, and the remaining 73 percent, mostly in Great Falls, has primary treatment only. Great Falls' present treatment plant, which has a BOD reduction of only 37 percent, is often overloaded during periods of heavy storm runoff and in early spring and summer when water levels are high and groundwater infiltrates into the system (6). The situation might be remedied with operation of the secondary treatment facility scheduled for completion by the end of 1973. Approximately 6,000 people in the Great Falls city-planning area are not connected to the city sewer, and the soil in most locations near the city is considered poor for subsurface sewage disposal.

The town of Vaughn has two sewage disposal systems, both inadequate. The original systems need extension to reach other homes, and secondary treatment is required. Here again the soil and geology are not well suited for subsurface disposal. In 1961 Cascade built a sewage lagoon on an island in the Missouri River. Not only does this system cause potential seepage and flooding problems, but projections indicate that the population of the village will soon exceed its capacity.

Metal-rich industrial sewage from the Anaconda Company reduction works in Great Falls has been a problem in the past. In 1968 Anaconda initiated a program to reduce the metal content of its effluent by returning it to the processing system. This has reduced chrome metal contamination of the Missouri River, but a break in the return pipeline on October 6, 1970 partially nullified previous cleanup efforts (6). Under normal operations, discharge from the Anaconda complex should be of minor significance to the river. Another source of Missouri River pollution, in this case severe, is from abandoned coal mines just south of Great Falls. Here acid mine drainage continues to enter the river via Sand Coulee, an old channel of the Missouri.

Great Falls, in common with other metropolitan areas across the country, continues to generate an increasing amount of solid waste and attempts to dispose of it on rapidly dwindling sites. In an attempt to cope with this, the city is planning a solid waste pulverizing plant to handle municipal garbage. Although the effort is an improvement, it still does not get to the heart of the matter: the wasteful habits of the American consumer and the American packaging industry. The problem, here as elsewhere, lies with a "throughput economy" as opposed to one that emphasizes recycling, reuse, and conservation of limited natural resources.

Flood control has been a major issue in the Glacier Foreland. In this subregion, as throughout the United States, residential and commercial development in valley bottoms have been the rule since early settlement when rivers were important links in the transportation system. In times past, the convenience of living close to the watercourse, the scarcity of people, and the abundance of land made the tradeoff with prime agricultural land appear acceptable. The subsequent population explosion and proliferation of government agencies dependent upon the construction of water storage projects for their existence have caused an unending spiral of flood control structures to make the floodplain suitable habitat for more people, who in turn demand more extensive protection of life and property.

Man's compulsion to build flood sensitive developments along rivers has in many areas required extensive large-scale manipulation that has deprived the floodplain of the soil-nutrient influx associated with flooding. Such manipulation has resulted in preemption of 60 to 80 percent of the urban floodplain in the United States (1). The Great Falls area has the potential for adding to that figure and for causing massive alteration of the Glacier Foreland and Columbia Rockies environments. Major flooding occurs every six to 10 years along the lower Sun River and pressures for major upstream impoundment persist. At present the only control structures on the Sun are Gibson Dam in the Columbia Rockies and a system of levees at Vaughn. For many years various state and private water development interests, led by the federal Bureau of Reclamation, have promoted multipurpose dams at a number of Sun River sites, including Lower Sun Butte, which would preempt about 55,000 acres of the Bob Marshall Wilderness, and Castle Reef, which would also invade the wilderness as well as inundate valuable recreation and wildlife lands outside its boundary. The ultimate benefits and costs of these sites and of Lowry, farther downstream near the agricultural community of Simms, have been an ongoing controversy that has intensified since the 1964 floods. Although public opposition to the proposed Sun Butte and Castle Reef Dams has thus far forestalled construction of either project, the Bureau of Reclamation continues to affirm their potential as a solution to Great Falls's flood problems.

Meanwhile, in view of the social and environmental costs of major impoundments, many Montanans are seeking alternative solutions. Not only is loss of wilderness, wildlife, recreation, and agricultural values a reason for questioning large impoundments, but also the fact that dams are subject to silt accumulation and, when eventually overladen with sediment, can cause flooding worse than it would be in an unobstructed river. Channelization, another traditional method of flood control, is also questionable, since the new channel simply transfers the threat downstream. Residential and commercial development of the Sun River floodplain in west Great Falls is already established. This situation represents an opportunity for the government flood control agencies to devise some long-range solutions that provide flood protection without complete alteration of the river.

In situations where floodplain development has not yet occurred, the old ounce-of-prevention pound-of-cure adage was never more true. Management of land use in the floodplain is the most effective method of mitigating the impact of floods and is generally the most economic of all flood-protection tools. Such management refers to a policy in which only floodable structures are constructed in the floodplain (no residences, public buildings, etc. are permitted), and the land is devoted to conservation, agriculture, and other flood-compatible uses. It is the old [illegible] method and the only one known in which man makes use of floods rather than tries to eliminate them by artificial means. This shift from engineering solutions to one based on ecological realities is the thrust of Montana's Floodway Management Act of 1971 (see 1971 legislative report in Chapter III). As the act is implemented, flood-plain delineations will eventually lead to regulation of floodway developments. Further incentive for land use control in floodplains is provided by the National Flood Insurance Act of 1968, which authorizes specified amounts of flood insurance previously unavailable from private insurers and directs state and local governments to adopt measures to limit and control land development in flood-prone locations.

The Glacier Foreland became one of Montana's early oil and gas producing districts when the Cut Bank field was discovered in 1926. The subregion's greatest current problem associated with petroleum and natural gas production is that of site disturbance, including unreclaimed mud pits, bulldozed sites, litter, and dusty, heavily used access roads. The marks of seismograph studies along the mountain front still persist several years after completion of exploration programs. Hurriedly prepared sites and roads carved into the mountainsides are highly erodible and are sources of sediment during periods of runoff. The impact of seismograph work, however, has been magnified by another impact more severe than the original. These trails provide easy access to forested areas for motorcycles, snowmobiles, and four-wheel drive vehicles, accompanied by the usual increase in litter, destruction of vegetation, and harassment of wildlife.

Two refineries, one each in Cut Bank and Great Falls, are in doubtful compliance with the state "sulfur in fuel" regulation, and the Cut Bank plant also is in noncompliance with the state "petroleum storage" regulation pertaining to hydrocarbon emissions. The Phillips refinery in Great Falls has significantly reduced its discharge of oils (458 mg/l — milligrams per liter — to 5.6 mg/l), phenols (14.5 mg/l to 0.02 mg/l), and BOD (332 mg/l to 7.9 mg/l) into the Missouri River in the last five years (6). The efficiency of treatment might not be as good during the colder months, but the reduction of pollutants should be adequate to meet existing water quality criteria.

Logging in the Glacier Foreland is not a major industry and is not shown on the matrix because until very recently it had no significant impact on the subregion. However, clearcutting begun this year on Hudson Bay Divide adjacent to Glacier National Park is destroying the setting for some of the world's most magnificent scenery. Public shock and concern over this extensive logging program have reached the news media, and hopefully plans will be modified to reduce environmental impacts, especially the visual insult to hundreds of thousands of visitors for whom Glacier National Park and its surroundings are the esthetic experience of a lifetime.

The Glacier Foreland, for all its contemporary problems and invading human uses, still retains the intrinsic environmental quality that Guthrie has lyrically expressed. Here still, as in other subregions of the Rocky Mountain Foreland and in almost all of eastern Montana, one can sense a landscape that is essential to the American dream: ". . . the great emptiness and age of it, the feel of westward mountains old as time and plains wide as forever and the blue sky flung across" (3). The spiritual and psychological value of such a landscape should be kept in mind through all the following perspectives of Great Plains Montana.

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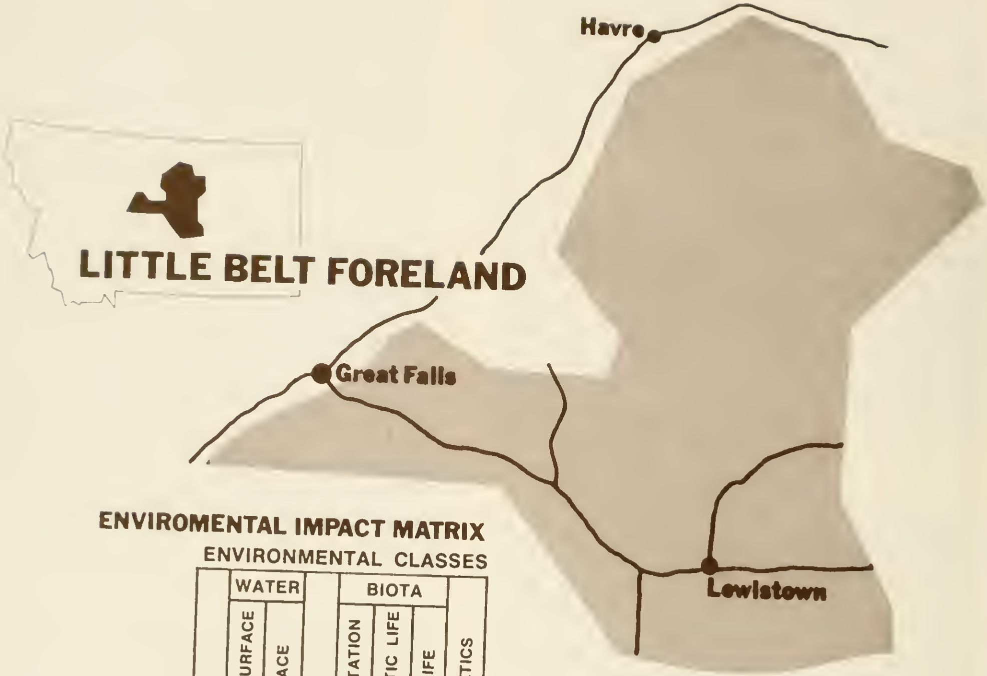
LITTLE BELT FORELAND



ENVIROMENTAL IMPACT MATRIX

ENVIRONMENTAL CLASSES

		WATER			BIOTA			
	AIR	SUBSURFACE	SURFACE	SOIL	VEGETATION	AQUATIC LIFE	WILDLIFE	ESTHETICS
DRYLAND FARM.			○	○	○		○	
GRAZING			○	●	●		●	
MINING			○	○	○			○
PETROL. PROD.	○	○		○	○		○	○
LOGGING	○		○	○	○		○	○
WOOD PROD.	○							○
RESIDENTIAL	○	○	○	○	○	○	○	○
TRANSPORTATION	○			○	○		○	○
COMMUN. & UTIL.				○	○			○
RECREATION				○	○		○	○

○ MINOR
● MAJOR

little belt foreland

The high upland topography of the Little Belt Foreland is separated north and south by the Missouri Breaks. The Breaks, a vast, quiet land, remains a virtual wilderness containing thousands of acres untenanted by man and scores of townships without a town or even a house. The loneliness, adverse conditions, and intense beauty of this part of the subregion were noted by journalist-historian Joseph K. Howard:

> **Even the swarming homesteaders, who plunged their plows into hillsides so steep they could not harvest crops from them, did not dare match their puny enterprise against the loneliness of the badlands . . . Scrub pine, spruce and cedar are scattered in the purple-shadowed coulees and on the hundreds of isolated hills which start up suddenly from the vast canyon floor; the sun, soon gone, rekindles briefly the centuries-old color in preglacial cliffs, and a distant mountain range turns violet, then black, against the blue-green sky (1).**

The Little Belt Foreland is also the open-range country of Charlie Russell, whose paintings and drawings elegantly convey the variability and unique visual dimensions of the subregion. Russell's work captures the mood and features of the landscape as a background for a way of life that is now mostly history but that still pervades the memory and sets the feeling for the Little Belt Foreland.

This subregion, near the geographical center of Montana, is a composite of features found in other parts of the state. Mountains rise to more than 5,000 feet in many places and are separated by broad lowlands. Arctic air masses invade the area a few times each winter but are usually of short duration and followed by warm, dry chinook winds. Ten to 14 inches of annual precipitation fall on the lowlands; the higher elevations receive more than 20 inches. Most of the lowlands are relatively undisturbed sedimentary strata, while the mountains are a complex of igneous rocks superimposed on the older sedimentary material. Vegetation varies from foothill grasslands and sagebrush in the lower elevations to ponderosa pine forests in the mountains.

The subregion currently has no designated wilderness areas, but does have a Bureau of Land Management Natural Area, Square Butte, near Geraldine. This 2,000-acre geologic feature, rising dramatically from the surrounding plains is managed to maintain pristine conditions.

Recreational resources have not been extensively developed, but a number of facilities exist and the opportunities for outdoor recreation in undeveloped areas are many and varied. Designated recreation facilities include three Forest Service campgrounds, three fishing access sites, and five state recreation areas, four of which are on the Missouri River Recreational Waterway. The Chief Joseph Battlefield of the Bear's Paw, Fort McGinnis, and Citadel Rock State Monuments are outstanding historic sites. Opportunities for hunting, fishing, photography, and other individual recreational pursuits are abundant in the small outlying mountain ranges, the Missouri Breaks, and throughout the region.

The Little Belt Foreland contains some very good deer habitat, but inadequate hunter kill and deer overproduction have resulted in generally deteriorated range conditions. The Snowy Mountains support one of the most productive white-tailed deer herds in the state. Although browse conditions there were rated only fair, white-tails in the Snowies produced in 1971 at a rate of 124 fawns per 100 adults. The terrain and cover throughout the subregion favor deer, especially mule deer, but in most locations 1971 browse conditions were rated poor to very poor, resulting in only fair to good production (50-75 fawns per 100 adults). A study in the Missouri River Breaks (2) suggests that hunting pressure in this area does not seem to be a factor in determining deer population trends and that forage deficiencies are the probable source of a fluctuating herd. Because forage is heavily overused, it appears that populations of both white-tailed and mule deer are on the decline and will probably be reduced during the next harsh winter.

Breeding-bird survey data from two routes indicate a wide variation in the number of nesting bird species throughout the Little Belt Foreland. Two years of data from a route near Leroy in Blaine County produced species counts of 18 and 19; a route near Highwood in Chouteau County varied between 10 and 16 during a four-year period. These averages represent the maximum and minimum number of bird species found along all routes in the Rocky Mountain Foreland.

Sagebrush spraying has been conducted in the Little Belt Foreland but has not been extensive; the control program has involved about 55,000 acres or 1.4 percent of the total area. Although it affects only a small portion of the subregion, this program is representative of attempts by modern agriculture to reduce natural diversity in the interest of higher production. Sagebrush eradication takes place at the expense of wildlife species such as mule deer, antelope, and sage grouse, which depend on the plant as a source of food and cover.

Impacts from recreational use have to date been limited, but one large development, the Rocky Boy Indian Reservation recreation complex, has caused some environmental problems from the beginning and is being expanded. The area lies in the Bear Paw Mountains, an out-of-the-way range that has little tourist traffic, and local demand for such a facility is probably insufficient to support it. The project has been poorly designed, maintained, and operated; expansion, including recent road construction, is causing further environmental degradation. In the Big Snowy Mountains, a ski area has been proposed at Crystal Lake south of Lewistown, but a Forest Service report indicates that ski area development in Crystal Lake Basin is probably impossible without degradation of the lake. Some parts of the area have a history of landsliding and slumping, and excavation for access roads and lift terminals could reactivate some old slides (4).

The Little Belt Foreland's most distinguished environmental feature and most important recreational and historic resource is the 150-mile stretch of Missouri River between Virgelle and Fred Robinson bridge, the longest and nearly the last stretch of the river that still flows free. This unique waterway, part of the Missouri Breaks, is unaltered by the activities of man and remains very much as it was when first viewed by explorers, trappers, and steamboat passengers. Here badlands have been cut to depths of more than 1,000 feet, weathering has moulded the white sandstone into a great variety of imaginative forms, and perpendicular dikes of dark brown igneous rocks jutting up through the white sandstone bluffs provide a contrast in color and profile that resembles the walls of ancient ruins. Campsites used by Lewis and Clark have been identified along the river route, which in many places is inaccessible except by water.

Numerous agencies, organizations, and individuals are looking at the Missouri River for a number of purposes, and its fate is perhaps the most significant environmental issue in the Little Belt Foreland. A major impoundment — High Cow Creek Dam — has been promoted for years by the Corps of Engineers and various developmental interests. The basic question is whether this section of the river is more important for its long-range recreation and historic value or for its short-range economic (construction) boom to local economies. The need for a dam has not been firmly established; among the numerous problems are a poor cost-benefit ratio, questionable geologic suitablity of both damsite and reservoir area, and the complete destruction of a unique historic and recreation resource. The dam would have no value for irrigation and little value for flood control because of the absence of permanent downstream residents. Its generating capacity would be of minimal significance to the state and the region. Recent resurgence of these dam proposals suggest that they may be related to forthcoming coal-based industrial development in eastern Montana.

If this portion of the river is preserved from impoundment and maintained as an historic and recreational area, the extent of development and the administrative authority will be topics of some debate. In March, 1971 Senator Metcalf introduced a bill to designate 175 miles of the Missouri River between Fort Benton and the Robinson Bridge as the Missouri Breaks Scenic Recreation River. The bill proposes a gradational use pattern with little disruption of existing uses. The upper portion, classified as a "recreational river," would be readily accessible by road, have some development of campgrounds and facilities along the shore, and could undergo some water impoundment. Most of the river in the Little Belt Foreland would be classififed as "scenic river" and "wild river." Scenic rivers are free of impoundments, with shorelines and watersheds still largely primitive and undeveloped although accessible in places by road. Wild rivers require primitive, undeveloped shorelines and no roads. The Metcalf Bill (S. 1405) calls for boundaries based on line of sight from the river and for management under the Taylor Grazing Act, which implies administration by the Bureau of Land Management and allows continuance of existing grazing and petroleum exploration. This bill has received strong support from state and national conservationists, local ranchers, Fort Benton residents, the 1971 legislature, and the Bureau of Land Management Montana Advisory Board. The National Park Service favors the structure of the bill, but would like to be named administrator of the area. The Bureau of Outdoor Recreation is considering this stretch of river for inclusion in the Wild and Scenic Rivers System.

Natural gas is the Little Belt Foreland's most valuable mineral resource. The Tiger Ridge gas field, on the flanks of the Bear Paw Mountains, has been termed the largest gas discovery in Montana in 40 years. Although production has been resticted by the absence of a link with existing markets, a recent Federal Power Commission ruling authorizing the export of Tiger Ridge gas has led to initial construction of a pipeline. The line will lead north from the gas field, join an existing pipeline system in southern Canada and reenter the United States in the Great Lakes region. The Federal Power Commission ruling and the export of gas are opposed by the Montana Power Company, which contends that the gas will be needed to meet instate demands in the near future. Extensive drilling in the last few years has caused environmental problems, including unreclaimed mud pits, litter, and dusty, heavily used access roads.

This portion of Montana experienced the gold rush of the late 1800's. Placer gold was discovered in the Judith and North Moccasin Mountains in the early 1870's and lode gold shortly thereafter in the same ranges and in the Little Rocky Mountains. Although the mines were generally small, they were numerous and had a severe impact on the area overlying the zone of mineral enrichment. Saturation prospecting was often the rule and has left many prospect pits and abandoned mines scattered about the countryside. Mining is presently restricted to sand, gravel, and a minor amount of gypsum and clay.

Recent mineral exploration has had a harsh impact on the soil, vegetation, and esthetics in some portions of the Little Rocky Mountains. Modern exploration techniques involve the use of bulldozers and other heavy equipment to expose fresh bedrock surfaces. These trenches have been dug, analyzed, and left to erode and revegetate as they will. As in many other areas throughout the state, reclamation in the Little Rockies has not been considered an integral part of the exploration process.

Wide expanses of well-grassed and well-watered prairie attracted pioneer cattlemen such as H. P. Brooks and Granville Stuart to this sector of Montana and made the Judith Basin one of the centers of open-range cattle ranching in the late 1800's. Agriculture continues as the economic mainstay of the Little Belt Foreland, with livestock and small grains the primary produce. Nearly all the unreserved land is used for agriculture, approximately 60 percent for livestock ranching only, 20 percent for cash-crop farming, and 20 percent for a combination of the two. Overuse of the range occurred as far back as the open-range days and continues today as the major ecologic imbalance in the subregion. Roughly 50 percent of the range needs some type of treatment. Better livestock management would improve the forage cover on 20 percent of the range and allow vegetative recovery on another 30 percent.

Most of the cash-crop farming, concentrated in the Judith Basin in the west-central portion of the subregion, has created environmental problems. Approximately 60 percent of the dry farmland does not receive treatment necessary to prevent soil loss and deterioration. The Soil and Water Conservation Needs Inventory (3) indicates that on this land some combination of strip-cropping, terraces, sod waterways, windbreaks, and/or crops providing better residual cover are needed.

Logging, mostly on private land, occurs throughout the subregion. Where conducted, logging has a significant effect on soil, water, vegetation, wildlife, and esthetics, but the impact in the Little Belt Foreland is not comparable to that of logging operations in Rocky Mountain Montana. Many species of trees found in these outlying mountain ranges do not lend themselves to clearcutting, and most of the timber taken to date has been from accessible locations, thus reducing the required number of roads. Logging could have a major impact in the near future, however. The absence of any form of control on private timber, in conjunction with a vigorous logging industry, threaten unplanned exploitation of the resource and destruction of some of the more heavily timbered watersheds in the subregion.

Manufacturing in the subregion consists of sawmills in Lewistown, Heath, Highwood and Hobson as well as two packing plants, two feed mills, and a fertilizer company, all in Lewistown. The subregion's mineral processing is restricted to Lewistown and consists of two ready-mix concrete operations and a concrete block and asphalt plant.

Because the Little Belt Foreland has good ventilation, few pollution sources, and a population density of only two people per square mile, its air pollution problems have been minimal. Agricultural activities such as burning and land clearing, burning dumps, and railroad right-of-way burning are temporary local problems, but insignificant on a widespread scale. Little or no air quality data for the Little Belt Foreland have been collected, but it may be expected that dustfall will be excessive in some communities. Sources of dust include winter sanding, construction, nearby agricultural operations, logging and travel on unpaved streets and roads. Heavy construction contributes little to air pollution, since no major projects are currently underway. Particulate concentrations probably average less than 50 micrograms per cubic meter.

Surface water quality in the Little Belt Foreland is generally very good. Its two major streams, the Missouri and Judith Rivers, are currently in compliance with Montana's water quality criteria as established by the Department of Health and Environmental Sciences.

All domestic water is presently derived from springs or wells. Groundwater chemistry varies, but it is for the most part suitable as drinking water throughout the subregion. Hardness and high iron content make the groundwater of marginal quality in Landusky and Zortman. At Denton it is unusable because of a high concentration of dissolved solids. Recent health department sampling of community water supplies indicates that rural groundwater in the region is partially contaminated. Coliform counts were made on samples from several communities, and the water at Moore and Judith Gap was found unsatisfactory. Most other supplies showed positive coliform counts but were satisfactory. Only Stockett and Sand Coulee showed no signs of biological contamination; however, acid mine drainage from abandoned coal mines south of Great Falls has greatly lowered the quality of Sand Coulee Creek.

Approximately half the population (9,158 people) of the Little Belt Foreland is served by public sewer systems. Lagoons and trickling filters provide secondary treatment for 28 percent of this segment while the remaining 72 percent receive only primary treatment through the use of septic tanks and mechanical clarification. The other half of the population is in individual homes outside of existing villages, which have individual septic tanks or no sewage treatment at all.

Residential development and heavy construction near Lewistown has resulted in channelization of some sections of Spring Creek, one of Montana's most productive trout streams. A trailer court and construction of missile silos were the major contributors in the degradation of this trout fishery.

An environmental perspective of the Little Belt Foreland indicates that its extraordinary historic and scenic values and its most important renewable resources — agriculture and recreation — are all viable at this time, but are seriously threatened by a variety of current or potential uses and developments. Certainly the subregion's traditional economic mainstays, livestock grazing and dryland farming, need careful innovative management if productivity is to continue. Certainly the mountains that rise above the broad plateau, the river canyons that cut the grassy uplands, need protection from uncontrolled mineral exploration and extractive uses, or the landscape that inspired Charles Russell may become nothing more than a sentimental memory. Certainly the last wild stretch of the Missouri River must remain free of impoundment if our national heritage is to be respected and enjoyed. Many of the irreplaceable environmental values of the Little Belt Foreland can be preserved in the modern context; options are still open for proper stewardship of this distinctive landscape at the heart of Montana.

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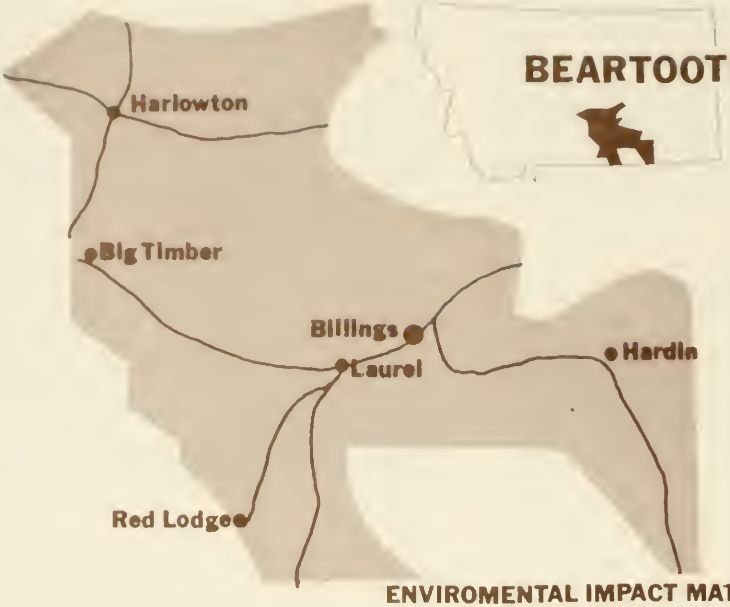
BEARTOOTH FORELAND



ENVIROMENTAL IMPACT MATRIX

ENVIRONMENTAL CLASSES

		WATER			BIOTA			
	AIR	SUBSURFACE	SURFACE	SOIL	VEGETATION	AQUATIC LIFE	WILDLIFE	ESTHETICS
IRRIGATED FARM.	○	○	●	●	●	○	○	
DRYLAND FARM.	○	○	●	●	●		●	
GRAZING			●	●	●	○	●	
AGRIBUSINESS	●	○	●	○	○			○
MINING			○	○	○			○
MIN. PROC.	○							○
PETROL. PROD.		○	○	○	○			○
PETROL. REF.	●	○	○					○
MANUFACTURING	○			○	○			○
RESIDENTIAL	○	○	●	●	●	○	○	●
TRANSPORTATION	○		○	○	○		○	○
COMMUN. & UTIL.				○	○			○
THERMAL POWER GEN.	○							○
RECREATION				○	○		○	○

○ MINOR
● MAJOR

Beartooth Foreland

Environmental Perspective

Backed by the grandeur of the Beartooth Plateau, spreading outward into river valleys and to other mountain ranges, is a warm and welcoming landscape. Its beauty and livability were eloquently described by the Crow Chief Arapooish:

> **The Crow country is a good country. The Great Spirit has put it exactly in the right place; when you are in it you fare well; whenever you go out of it, whichever way you travel, you fare worse . . . The Crow country is exactly in the right place. It has snowy mountains and sunny plains; all kinds of climates, and good things for every season. When the summer heat scorches the prairies, you can draw up under the mountains, where the air is sweet and cool, the grass fresh, and the bright streams come tumbling out of the snowbanks . . . (8).**

The Beartooth Foreland differs from other foreland regions in its topography and land use. It contains none of the outlying mountain ranges and has gentler uplands more conducive to dryland farming. It is not a "soft" landscape, however, for high hills twist toward the mountains, and streams have cut through overlying sandstone formations to form precipitous bluffs, the best known of which are the rimrocks at Billings.

The climate is marked by abundant sunshine, low relative humidity, moderate winds, low precipitation, and wide seasonal and daily temperature variations. Hot summer days are usually tempered by cool breezes from adjoining mountain ranges. Severe summer hailstorms, a weather phenomenon for which Billings is well known, are common occurrences in late July and August. The winters are mild, for Montana, periods of extreme cold usually last only a short time.

The Beartooth Foreland contains no national forestland and no existing or candidate wilderness areas, however, the subregion has several developed historic sites including the Custer Battlefield National Monument, Pictograph Cave State Monument, and Pompey's Pillar National Historic Landmark. Perhaps the most attractive of the developed sites is the Chief Plenty Coups Memorial Monument near Pryor. It consists of a handsome picnic ground on Pryor Creek, the Chief's dwellings, and a museum featuring Crow Indian history and culture. The subregion also contains two state recreation areas and three national wildlife refuges.

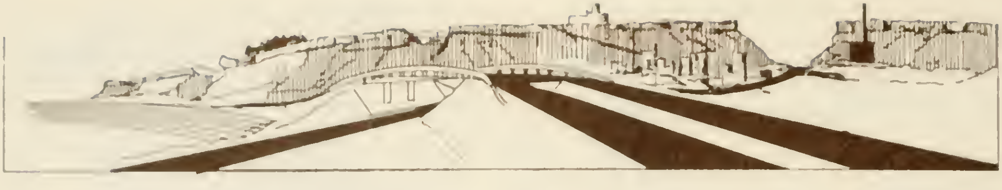
Several rivers flowing from adjoining uplands, the grassy plateaus, and the rocky, heavily timbered hills against a backdrop of mountains in nearly every direction give the Beartooth Foreland an unusual diversity of open space. Hunting and fishing are the primary recreational activities, and although none of the streams have been designated Class 1, several that flow from the Beartooth Range are productive salmonid fisheries. The Department of Fish and Game maintains 10 fishing access sites totaling about 640 acres.

Deer are found throughout the subregion, but are most abundant in the peripheral foothills. Sketchy information on deer range indicates generally poor conditions, probably a result of excessive grazing of private land leading to inadequate hunter kill and deer overpopulation. The northern two-thirds of the Beartooth Foreland is good antelope range and provides huntable populations, but competition with other land uses restrict their numbers. Sagebrush eradication programs, involving 120,000 acres in this subregion, have been detrimental to antelope movement and survival.

The desire to combine the amenities of city and rural life has resulted in the spread of residential development in nearly all directions around Billings. As of March 1, 1972 Montana Department of Revenue records showed over 13,000 acres assessed as suburban small tracts in Yellowstone County, most of which were in the Billings vicinity. Additional land has been preempted for industrial expansion and highway construction. The city is booming and paying, in the form of worsening air pollution, one of the immediate costs of urbanization.

Montana's air pollution control implementation plan (1) requires a particulate reduction of 37 percent in the Billings-Laurel "hot spot" to meet the annual geometric mean of 60 ug/M³. The required reduction is based on estimated air quality since representative data is available for 1970. Monitoring conducted in 1966-67 gave a higher annual geometric mean of 92 ug/M³ and a 24-hour maximum of 400 ug/M³, but enforcement of open burning regulations and better dust control have improved air quality. It is predicted that the desired particulate level in the Billings area can be achieved by completion of control programs at two petroleum refineries and one sugar beet plant (1). The Humble Oil Company coker more than doubles the hourly particulate emission standard of 74 pounds, and stack tests indicate that the scrubbers at the Great Western sugar refinery are not in compliance. Recent modifications have brought the Continental Oil Company into compliance with particulate emission standards. Although within the allowable dust emission standard of 417 pounds per hour for coal fired steam electric generators, the J.E. Corette plant in Billings emits 120 pounds of particulate per hour.

The Billings-Laurel area will require a 17 percent sulfur dioxide reduction to comply with the annual arithmetic mean of 60 ug/M³. Section II of Montana Regulation 90-008 states that commencing July 1, 1972 no person shall burn fuels containing in excess of one pound sulfur per



one million BTUs fired. Compliance with this regulation will accomplish a 29-percent reduction in the area's sulfur oxide emissions (1). Major industrial contributors are the Humble Oil, Continental Oil, and Farmer's Union refineries, the Corette steam generation plant, Montana Sulfur Company, and Great Western.

In addition to high sulfur dioxide and particulate levels, Billings has air problems uncommon to other cities in the state. One such problem is that of odor, derived from the Humble and Continental refineries, Great Western, and the Pierce and Midland Empire packing plants within the Billings city limits. Another problem involves high fluoride concentrations in rodents and vegetation downwind from the Corette plant, but more extensive work is needed to pinpoint the source and assess present and potential damage.

Expanding urbanization of the Billings area may also be exacting a more profound, long-lasting, and irredeemable cost than degradation of air quality. Most of the land preempted for residential, industrial, and highway development was formerly in productive agriculture. Records of the Soil Conservation Service at Billings show that Yellowstone County lost over 8,000 acres of agriculturally productive land for this purpose in the last 10 years; 6,750 acres were taken by urban sprawl, and 1,600 acres by highway construction. The serious, long-term impact of these tradeoffs stems from the fact that the greater part of the loss involved the most productive lands on Class I (3,800 acres) and II (2,250 acres) soils.

Although current increases in productivity or surpluses make such losses appear inconsequential, the long-term picture is quite different. Increases in productivity have been gained through large inputs of energy and fertilizers. It is estimated that known reserves of phosphorus will be exhausted before the end of the twenty-first century. Without phosphate fertilizers, the planet can support between one and two billion people (4), yet the world population is expected to reach seven billion by 2000. In light of these predictions, care should be exercised to prevent irreversible commitments of productive agricultural land. In Billings and elsewhere, steps should be taken to channel urban development and highway systems to areas unsuitable for agricultural production.

As in the rest of the Rocky Mountain Foreland, livestock ranching in the Beartooth subregion is the leading industry. Dryland farming is practiced in the Billings, Laurel, and Big Timber vicinities. Since the bison was displaced from the grass-covered hills, range abuse from domestic livestock has been the rule rather than the exception. In 1967 almost 70 percent of the range in the Beartooth Foreland was overgrazed and in need of treatment to improve plant cover and reduce soil erosion (6). That year also, about two-thirds of the cropland in tillage rotation needed some type of treatment, usually strip cropping, terracing, diversions, crop residue, or annual cover to stabilize the topsoil (6). Wind and water erosion have both been classified as severe in the subregion (3).

Broad floodplains and dependable water supplies from three major rivers in the southern half of the subregion have made irrigated farming more important here than in other parts of the Rocky Mountain Foreland. Irrigation of approximately 277,000 acres of land, primarily in the Yellowstone, Bighorn, and Clark Fork of the Yellowstone Valleys, has created some serious water contamination problems. Silt in the Clark Fork, a river that in Montana exceeds state limits for turbidity, is derived from highly erodible geologic strata upstream and aggravated by poor irrigation and soil conservation practices in the basin. Of the total irrigated cropland in Carbon and Yellowstone Counties, about 96 percent and 80 percent respectively are in need of improved irrigation systems, including reorganization of present systems for increased efficiency, land leveling, ditch lining, and erosion control structures (7). Wasteful irrigation has been the prime factor in the obliteration of trout populations in lower Bluewater Creek and in the entire Montana portion of the Clark Fork of the Yellowstone (7). It can also be assumed that the extensive irrigation along the Yellowstone and Bighorn Rivers contributes significantly to the contamination of these streams during periods of maximum wastewater return. Water erosion and siltation have been considered severe throughout the subregion.

The climate, soils, market, transportation facilities, and diversity of agricultural activities in the Billings area favor large-scale production of beef in confined lots. The three most serious water problems associated with feedlots are oxygen depletion, pathogenic bacteria, and increased nutrient content. Drainage from feedlots must be contained, treated in some manner, and prevented from discharging into a water course; and accumulated solid wastes must be disposed of. Stockpiles of waste attract vermin and pollute groundwater and surface water during periods of high rainfall and snowmelt. Nonsalvage techniques such as incineration or landfill are also ill suited to agricultural wastes. Sprinkler irrigation of these wastes warrants close scrutiny, particularly in areas of intense farming.

Because none of the three large feedlots in Yellowstone County have been subjected to heavy runoff, no contamination of surface water in the area has been recorded to date. Testing of wells on a feedlot west of Billings showed a slight increase in nitrates, but the concentrations were below the 45 ppm (parts per million) maximum for drinking water specified by the U. S. Public Health Service. However, the Department of Health and Environmental Sciences (2) indicates that additional feedlots will probably be constructed in the county and that this activity has a greater pollution potential than any other local industry.

Yegen Drain, a ditch through south Billings to the Yellowstone River, is the traditional recipient of a good deal of the city's industrial sewage, but has been significantly improved. For 66 years prior to 1969 it received raw sewage from two meat-packing plants, oil-contaminated wastes from two refineries, and organic-laden wastes from the sugar refinery. All these installations are now connected to some type of wastewater treatment facility, but for a short time following beet harvest in the fall Great Western's effluent exceeds the capacity of its settling ponds and flows via the drain into the Yellowstone. When the plant is operating, commonly called the campaign, it discharges about five million gallons of 80° F. water per day (5). Continental Oil still discharges into Yegen Drain, but the water has been treated to comply with state laws. Other sources of contaminants that find their way into the drain and the river include small pasture areas, septic tank effluents, and storm drains that often contain oil-laden service station wastes.

Billings now has only primary sewage treatment. Not only does the system serve the city's 61,000 people, but two meat-packing plants as well. The latter tied into the system in 1969, since which time suspended solids and BOD levels in the city's effluent increased 65 percent and 50 percent respectively. The city's sewage plant, which currently removes 50 percent of the BOD and 98 percent of the coliform bacteria, will be improved substantially with completion of a secondary treatment facility by the end of 1974. About 9,600 people on the periphery of the Billings city-county area are not connected to the city sewer and utilize septic tanks and subsurface disposal. Some surfacing of septic tank effluent has occurred in the most extensively developed portions of Billings Heights. Because metropolitan Billings is surrounded by productive agricultural land, sprinkler irrigation of domestic sewage is a possibility that should be carefully considered (Chapter IV). In the Beartooth Foreland as a whole, wastes from only 17 percent of the sewered population receive secondary treatment.

Laurel (population 4,454) also is served only by a primary sewage plant, which has an effective BOD removal of 50 percent and discharges into the Yellowstone River. This system is subject to periodic influxes of oil from the Burlington Northern yards and to infiltration of contaminated groundwater in the vicinity of the Farmers Union refinery.

The Elk Basin oil field south of Bridger has been the source of water contaminants that periodically escape into Silvertip Creek and the Clark Fork River. The field is in rough topography and the sludge pits — the recipients of an oil, water, and sand mixture from storage tanks — are located in the drainage bottoms. Skimming ponds have been installed but are largely ineffective. Runoff from occasional heavy rains washes out the dikes around the dumps and carries the tarry sludge down the creek and into the river. These washouts have occurred three or four times during the last decade; one, in the spring of 1972, left streambanks coated with oil the entire length of Silvertip Creek and three miles down the Clark Fork below the confluence. The entire field is in deplorable condition. Soil and vegetation have been severely affected, but almost no remedial action has been taken. Confusion exists over the question of authority, partly because the field lies in two states. Federal action may be required to resolve this problem.

Health department inspections of public drinking water supplies in the subregion showed varying degrees of contamination in 1971. Water for the communities of Red Lodge, Joliet, and Ryegate were found unsatisfactory. Signs of coliform contamination in 10 other public supplies, including those of Laurel, Absarokee, and Columbus, were insufficient to warrant unsatisfactory ratings. Water in Billings and 11 other towns gave no indication of biological contamination.

In the Beartooth Foreland some forward steps have been taken, but the remaining problems are large. Regulation of emissions has improved air quality, and the cleanup of Yegen Drain and the future operation of Billings' secondary sewage treatment will upgrade the quality of water in the Yellowstone River. However, serious existing and potential water problems, such as irrigation return and feedlot runoff, are receiving very little attention. The greatest environmental problem in the subregion is probably long-range, uncontrolled urban development with preemption of prime agricultural land. In Billings, urban sprawl continues to destroy elements of the city's original charm — development of the cherished rimrocks appears certain. "The good things for every season" have been abused in the past and continue to be in grave danger.

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BIGHORNS

ENVIRONMENTAL IMPACT MATRIX

ENVIRONMENTAL CLASSES

		WATER			BIOTA			
	AIR	SUBSURFACE	SURFACE	SOIL	VEGETATION	AQUATIC LIFE	WILDLIFE	ESTHETICS
GRAZING			○	●	●	○	●	○
MINING				●	●			●
LOGGING				○	○		○	○
TRANSPORTATION			○	●	●		○	●
COMMUN. & UTIL.				○	○			●
WATER STORAGE		○	○	●	●	○	●	○
RECREATION			○	●	●		○	○

○ MINOR
● MAJOR

Bighorns

Environmental Perspective

> **The country belonging to the Crows was not only beautiful, but it was the very heart of the buffalo range of the Northwest. It embraced endless plains, high mountains, and great rivers, fed by streams clear as crystal. No other section could compare with the Crow country, especially when it was untouched by white men. Its wealth in all kinds of game, grass, roots, and berries made enemies for the Crows, who, often outnumbered, were obliged continually to defend it against surrounding tribes (4).**

The Bighorns subregion of the Rocky Mountain Foreland is a uniquely beautiful part of Montana and the center of Crow country, encompassing the bold forested Pryor Range on the west, the nearly spent grassy northern extremities of the Bighorns on the east, and the spectacular gorge of the Bighorn River between. It is an area that appeals to all the senses and any or all conceptions of environmental attractiveness. In no other place in the state, within a distance of 15 miles and an elevational change of 5,000 feet, do vegetational types range from true desert shrub to subalpine forest and meadow. Although the smallest of the environmental regions and subregions in both population and size, it is perhaps the richest in Indian legend and religion. It has undeniable mystical and spiritual qualities.

Long before whites invaded the subregion, the Crows sought out the lofty sanctuaries of the Bighorn and Pryor Mountains to perform their fasting rituals, intended for many religious purposes, including guidance of boys into manhood. Just as aboriginal inhabitants benefited from the recreative and renewal powers imparted by this grand and picturesque landscape, so today do refugees from our hectic society.

The Bighorns subregion provides a variety of recreational experiences to residents of the Beartooth Foreland, the Bighorn Basin of northcentral Wyoming, and beyond. Mule deer, elk, black bear, mountain lion, bobcat, blue grouse, and prairie dogs are endemic to the area and exist in varying numbers. Exotic game birds have also been introduced for those who wish to hunt: ring-necked pheasant in the lower drainages, Hungarian partridge in the foothills, and Chukar partridge on low-lying, dry, grassy ridges. The grizzly and the timber (gray) wolf, former residents, are now extinct here, as was the bighorn sheep for many decades prior to 1973 when it was reintroduced into the Pryor Mountains. The herd now appears healthy and thriving (2). Plans are also underway by the Crows to reintroduce [illegible] habitat lands across the Bighorn River in the Bighorn Mountains (9). Wild horses, descendants of stock from Indian villages and ranch and farm stock, roam the Pryor Range.

Between the formidable eastern slope of the Pryors and the grassy roll of the northern Bighorns, the Bighorn River has cut a most impressive canyon, incised nearly a quarter mile into the upwarped rock layers of the Bighorn anticline. Francois Antoine Larocque, a trapper and trader for the Northwest Fur Company, climbed the west wall of the canyon on August 31, 1805 and wrote, "It is awful to behold and makes one giddy to look down upon the river." He also noted that the walls of several side canyons were "as smooth and perpendicular as a wall, and are of amazing height" (1). Larocque's reaction to Bighorn Canyon was no more spectacular than most visitors' reaction today, in spite of the fact that several hundred feet of the lower canyon walls have been inundated since his time.

Bighorn Lake, 71 miles long and over 400 feet deep, was created in the canyon upon completion of Yellowtail Dam in 1965. Offering outstanding opportunities for water-based recreation, the lake allows long access to the 47-mile length of Bighorn Canyon. Fishing is excellent, whether along the river below the dam, on the reservoir, or in the trout streams that feed the lake from the mountains on either side. The region contains several miles of trout streams — the Bighorn River, Little Bighorn River, and Lodgegrass Creek — rated as Class 1 fishing waters important to large areas of the state. The upper 30 miles of Pryor Creek are included in the region and are rated Class 4 (of value to smaller districts such as counties). Aside from hunting and fishing, other activities and attractions on surrounding terrain include camping, picnicking, hiking, riding, bird and wildlife watching, and features of historical, archaeological and geological interest.

The Pryor-Bighorn complex is one of the richest archaeological areas in the continent and has the greatest concentration of diverse sites of the Northwest Plains Indians (3). In only three summers of professional exploration nearly 300 sites have been recorded, including camp sites, tepee ring concentrations, cribbed-log structures, fasting sites, fortifications, trails, rock cairns, buffalo jumps, petroglyphs and pictographs. Evidence indicates aboriginal occupation extended back at least to 10,000 B.C., when hunters of the great late Pleistocene fauna roamed the Pryor Mountain area (3). Before occupation by the Crows in the 1700's, the subregion had been used by other nomadic buffalo-hunting tribes. Historic records and archeologic evidence speak of Shoshone, Blackfoot, Atsina, Cheyenne, and possibly Kiowa use of the Pryors following A.D. 500. Between the era of the prehistoric hunters and the latter date, a foraging culture existed, using both big game and a variety of plants, berries, seeds, and roots prepared with grinding stones and roasting pits.

Following Larocque, the area was explored by John Colter and George Drouillard, both in the employ of Manuel Lisa of the Missouri Fur Trading Company. Later, during the height of the fur trade, Jedediah Smith and Jim Bridger visited the subregion and the Bad Pass route — "a rugged and frightful route" — was pioneered between the Bighorns and the Pryors for the purpose of transporting pelts to market (1). By virtue of geographic location, topography, climate, and resource diversity the area eventually became as attractive to loggers, miners, ranchers, farmers, hunters, and recreationists as it had been to men of the fur trade and the aborigines who preceded them.

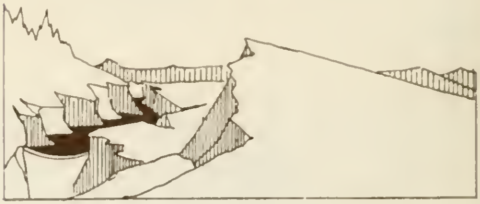
The aura and essence of the Bighorns is derived from its varied geology and stratigraphy which impart a galaxy of color and form combinations. The warm pastels and hazy vistas of a Painted Desert, the craggy and stratified buttresses of a Grand Canyon, and the intermingled hot oranges and cool gray-greens of an Oak Creek Canyon are all visually represented in microcosm in the subregion. Time is also in evidence: the exposed rocks of Bighorn Canyon span more than 500 million years, the ice caves high in the Pryors are reminders of more recent glacial times, and the dams, roads, and other structures represent the scant century and a half since the ingress of modern man.

Only a fraction of the Bighorns subregion is in private or state ownership, with the major share under various degrees of management and development by five federal agencies: the Crow Reservation under the Bureau of Indian Affairs; Custer National Forest under the Forest Service, Bighorn Canyon National Recreation Area under the National Park Service (NPS); Pryor Mountains Wild Horse Range and other public domain lands under the Bureau of Land Management (BLM); and Yellowtail Dam and power facilities under the Bureau of Reclamation. Together, these agencies offer a spectrum of recreational development, including the Ok-A-Beh (Pretty Eagle) facility on Bighorn Lake, other facilities at Barry's Landing and Afterbay, and Sagecreek campground and Big Ice Cave picnic ground in the Pryors. Similarly, much of the thrust of human impact in the Bighorns has resulted from federally sponsored or sanctioned activity.

Grazing by horses, sheep, and cattle on Pryor Mountain foothills has transformed semiarid grassland into desert and fragile desert-shrub ecosystems into virtual wastelands. Impacts have been most pronounced on soils, vegetation, and wildlife populations. In recent years, however, the Bureau of Land Management has established a program of rest-rotation grazing which has allowed recovery of natural forage in some areas. Livestock grazing pressure on Forest Service land in the Pryors has been less intensive. Sheep and cattle numbers appear to be in balance with available forage but a conflict could arise should the planted bighorn population expand its range and compete with domestic sheep (10).

Unchecked deer numbers in the 1940's and 1950's caused extensive winter range deterioration, which culminated in the 1960's with deer mortality from starvation or poor nutrition (6). The Pryor Mountains deer population has since stabilized at a lower density level. Fawn production was rated poor in 1971 and range conditions very poor (5).

In many locations, uranium exploration has involved poorly planned, hastily built roads and a network of dozer trails as well as removal of substantial amounts of overburden by heavy earth-moving equipment. Soils and vegetation have been adversely affected, with significant infringement upon the area's esthetic quality.



The legislation authorizing establishment of Bighorn Canyon National Recreation Area provided for development of access. Subsequent plans for a high-standard road along the western edge of the canyon connecting Fort Smith, Montana with Lovell, Wyoming have generated substantial controversy. Opposition stems from the fact that the proposed road would transgress remnants of religious sanctuaries and burial sites of the Crow Tribe as well as disturb other archeological sites — particularly the buffalo jumps — mentioned previously. In the words of Henry Old Coyote, Crow cultural leader, "It's like building a road through the graves of Arlington Cemetery." The first 5.6-mile section of the 20-mile road has now been pushed through, from Horseshoe Bend to Devil's Canyon Overlook, apparently without application of environmental principles and certainly without issuance of an environmental impact statement (3). In addition to molesting valued cultural shrines, this and other elements of the transportation system have had a detrimental impact on fragile ecosystems and esthetic amenities. Electric transmission lines from the power plant at Yellowtail Dam, extending south along the rim of the canyon and west over the Pryors, have also created a major esthetic intrusion into this scenic landscape.

The extremely segmented administration of the land area and the lack of a coordinated management program in the Bighorns subregion have often precipitated conflicts among government agencies and private interest groups. One example of administrative complexity is the Pryor Mountains Wild Horse Range: the 32,000-acre range was established in 1968 on the southeastern slopes of the Pryors adjacent to Bighorn Canyon. The range encompasses both BLM and NPS land, including a portion of the Bighorn Canyon National Recreation Area. Although the BLM was given authority to manage the horse herd over the entire range, its management objectives on the NPS portion are in all respects subordinate to the primary objective of the recreation area — recreation. The proposed high-standard road and the travelers it will carry will invade the winter range of the wild horse herd, disrupt natural animal movements, and separate the horses from water and forage. Further aggravating the situation is the fact that 6,000 to 7,000 head of cattle are permitted through the Bad Pass corridor every spring and fall as they are driven to and from winter range. The cattle cross the horse range and have a significant impact upon available forage (6).

Water storage behind Yellowtail Dam inundated several thousand acres of important winter game range in Bighorn Canyon. Impoundment and deepwater withdrawal have affected water quality in the Bighorn River. They have delayed the normal spring rise and autumn decline of water temperatures, increased minimum temperatures, decreased turbidity, delayed the discharge of minimum salinity water to correspond with heavy downstream irrigation, caused taste and odor problems downstream, and greatly enhanced fish productivity below the dam (7). Deepwater withdrawal has also resulted in the discharge of low oxygen and low pH water with limited capacity for satisfying downstream biochemical oxygen demands.

Recreationists, including game hunters, pot hunters, sightseers, rockhounds, and other outdoor enthusiasts, have had a significant adverse impact upon fragile terrestrial ecosystems in the Bighorns subregion. Off-road vehicular use has been a major source of disruption. Increased pleasure-boat traffic on Bighorn Lake has degraded the esthetic experience of canyon touring and has produced safety hazards.

Fort Smith, immediately below Yellowtail Dam, is the only community in the subregion. It is named after old Fort C. F. Smith, an infantry post established in 1866 along the Bozeman Trail to protect travelers from the Sioux and Cheyenne. The trail skirted the Bighorns and Pryors to the east and north and was considered by the Indians to be an encroachment on their hunting grounds.

Fort Smith sewage receives lagoon treatment, while sewage from the Yellowtail Dam complex (about 30 persons) receives activated sludge treatment. Both are forms of secondary treatment. The water supply was listed as free of contaminants by the Department of Health and Environmental Sciences for 1974.

No useful air quality information is available for the subregion. The Bureau of Reclamation no longer burns trash at its Yellowtail headquarters but uses a landfill. Slash burning has not been practiced on the Pryor unit of the Custer National Forest for two years (10).

In the final analysis, the integrity of the Bighorns subregion — its ecologic communities, its Indian heritage, and its singular beauty — will depend on sensitive coordination and management by the Crow Tribe and government agencies to restrict further encroachments on this precious land. Intensive development such as the proposed high-standard National Park Service road along Bighorn Canyon, with its inevitable attendant traffic as well as recreational pressures, can only destroy a natural and cultural resource of timeless value. If the region is carefully preserved, perhaps in some small measure the expectation of Chief Plenty Coups can be fulfilled:

> Remember this, Sign-talker, and help my people keep their lands. Help them to hold forever the Pryor and Bighorn mountains. They love them as I do and deserve to have them for the help they have given the white man, who now owns all (4).

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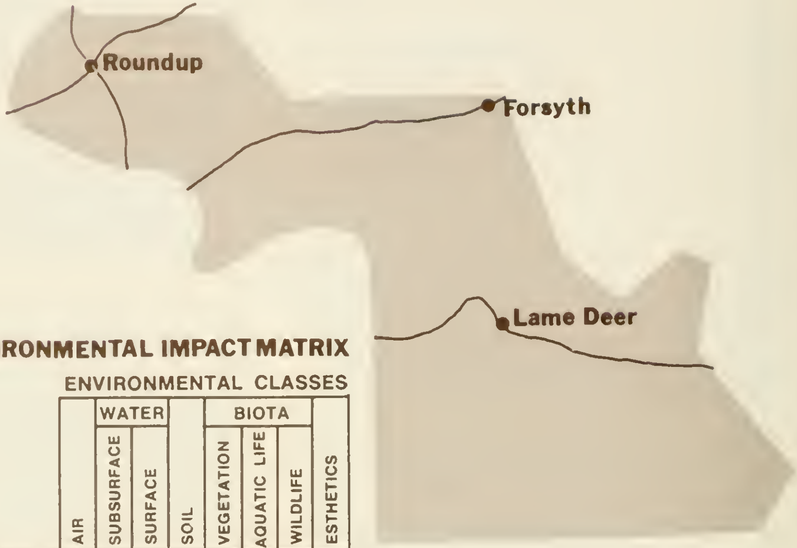
PINE PARKLANDS



ENVIRONMENTAL IMPACT MATRIX

ENVIRONMENTAL CLASSES

		WATER			BIOTA			
	AIR	SUBSURFACE	SURFACE	SOIL	VEGETATION	AQUATIC LIFE	WILDLIFE	ESTHETICS
IRRIGATED FARM			○	○	○	○		
DRYLAND FARM.				○	○			
GRAZING			○	●	●	○	○	
MINING	○	○	○	●	●		○	●
PETROL. PROD.		○		○	○			○
LOGGING	○		○	○	○	○	○	○
WOOD PROD.	○							○
RESIDENTIAL		○	○	○	○			○
TRANSPORTATION	○		○	○	○		○	
COMMUN. & UTIL.				○	○			○
THERMAL POWER GEN.				○	○			○
RECREATION				○	○		○	○

○ MINOR
● MAJOR

Pine Parklands

Environmental Perspective

This Foreland subregion is a golden land, a land of buff colored sandstone cliffs, ochre-tinted ponderosa pine bark, and expanses of yellow grass. The landscape seems to glow under the hot summer sun. It is intimate — with a feeling of closeness between man and earth. In his travels in 1880, Granville Stuart commented on the intrinsic quality of the Parklands.

> **We are passing through what is called the canyon where the Rosebud cuts through the Big Wolf Mountains, but it is not much of a canyon, being never less than one mile wide and with beautiful little grassy vales extending back among the picturesque castilated red buttes which have considerable nice yellow pine scattered over them . . . buttes and bastioned fortresses of all shapes and sizes capped and often landed with broad belts of vivid red scoviacious shelly rock, crowned with beautiful clumps of yellow pine trees and in many of the glades and sags are fine groves which add much to the beauty of the scene and where burned off, the hills are green with new grass (5).**

The topography of the subregion reflects the variability of the underlying sedimentary strata. It consists of broad rolling uplands, angular sandstone-capped buttes and spurs, and deeply dissected badlands where shale beds have been exposed to running water. The northern and southeastern portions are characterized by low hills covered with dense growths of ponderosa pine. Elsewhere trees are generally restricted to the coarse, poorly developed soils associated with sandstone outcrops. To the south the presence of coal is ever more apparent as it begins to appear in outcrops, and the colorful clinker capped ridges become the distinguishing feature of the landscape. Clinker or scoria is a red sedimentary rock fused or baked by heat rising from smoldering coalbeds. These beds more effectively resist erosion than most unaltered sediments and thus remain topographically high when exposed.

Recreational opportunities include camping, picnicking, hiking, and fishing, but the subregion contains no parks, monuments or wilderness. The Forest Service maintains three camp and picnic grounds in the Custer National Forest. Of the three, only the Red Shale campground on U.S. Highway 212, six miles east of Ashland, is heavily used. The Northern Cheyenne Indians operate four campgrounds on the reservation but these facilities are used infrequently.

The Tongue River Reservoir is the only lake in the subregion of sufficient size to allow water-based recreation. Overuse of this popular recreational facility has caused litter, trampling of vegetation, accelerated erosion, and sanitation and waste disposal problems.

The portion of the subregion south of the Yellowstone River has been classified by the fish and game department as one of the finest deer areas in the state (1). Mule deer thrive in the open country, which contains an adequate supply of browse plants interspersed with escape cover of moderate to heavy timber and brushy draws and coulees. However, degradation of deer range through overuse is common. In the northern part of the subregion, inadequate hunter harvest coupled with poor production of deer resulted in seriously deteriorated range in the early 1960's and a severe die-off during the winter of 1964-65. This natural selection allowed partial recovery of the range, and deer production has increased in recent years. Deer range in the northern sections, which includes the Bull Mountains, is in poor condition as indicated by an average herd production of only 58 fawns per 100 adults in 1971 (4). The topography of the Pine Parklands allows hunting from all sorts of off-road vehicles, an arrangement that has had a disruptive effect on vegetation in some locations.

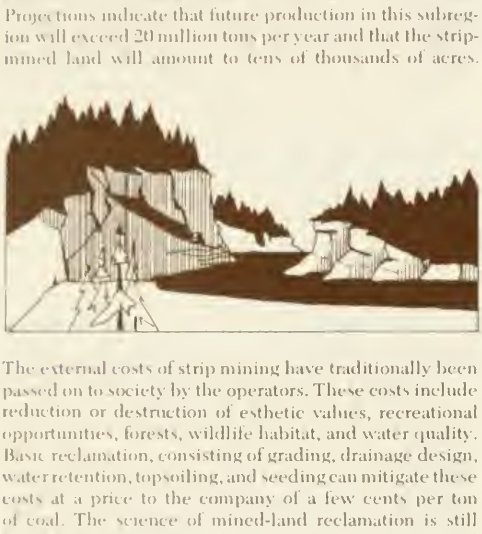
Dense growths of ponderosa pine and irregular topography in the Bull Mountains and the Ashland district of the Custer National Forest provide excellent wild turkey habitat. The first release of turkeys in the Pine Parklands was made near Ashland in 1957, since which time the species has flourished and provided huntable populations in several areas.

Agriculture is the backbone of the economy and currently has the most widespread environmental impact. Overgrazing by livestock and plowing of native grasslands unfit for farming have adversely affected soil and vegetation in some parts of the subregion. More than 50 percent of the range and pastureland needed treatment in 1967, and the Department of Fish and Game estimated that most of the streams in Rosebud and Treasure Counties are degraded by overgrazing along the banks. The Soil and Water Conservation Needs Inventory (9) suggests that in most cases proper livestock management will allow the vegetation to recover and erosion to diminish. Dryland farming occurs where the terrain permits but is secondary to livestock on most of the uncultivated land. Irrigated tracts are scattered along the Yellowstone, Big Horn, and Tongue Rivers but are less extensive than along the same rivers in other regions.

This agricultural portion of Montana is one of the most sparsely populated areas in the state. It averages about one person per square mile and contains no cities larger than 2,500 people. However, beneath this quiet agrarian land lies the resource that could change the character of the entire state — billions of tons of strippable coal.

Eastern Montana coal is one of the last opportunities to exploit a resource for the temporary accomodation of an insatiable demand for energy. Coal stripping threatens disfiguration of thousands of acres of prairie and pine-covered hills. Almost nothing can so completely blight the natural beauty and destroy the productivity of the land as an open cut mine. To date, reclamation has been attempted on less than five percent of the strip-mined land in Montana. At Colstrip unreclaimed mine spoils from the 1920's are deeply eroded and nearly devoid of vegetation.

The Pine Parklands is the initial target of the coal developers. Much of the area has been thoroughly investigated and it contains three of the state's four operating strip mines. In 1972 these mines are expected to produce about 7.7 million tons of coal and disturb 130 to 250 acres. Projections indicate that future production in this subregion will exceed 20 million tons per year and that the strip-mined land will amount to tens of thousands of acres.



The external costs of strip mining have traditionally been passed on to society by the operators. These costs include reduction or destruction of esthetic values, recreational opportunities, forests, wildlife habitat, and water quality. Basic reclamation, consisting of grading, drainage design, water retention, topsoiling, and seeding can mitigate these costs at a price to the company of a few cents per ton of coal. The science of mined-land reclamation is still in its infancy, but if the known techniques mentioned above are applied, some of the land can be restored to a productive use. If not, the following observation by Representative Ken Hechler, West Virginia, might aptly describe the Pine Parklands after the coal has been removed.

> **Strip mining is like taking seven or eight stiff drinks; you are riding high as long as the coal lasts, but the hangover comes when the coal is gone, the land is gone, the jobs are gone and the bitter truth of the morning after leaves a barren landscape and a mouth full of ashes (1).**

Even the best reclamation of stripped lands cannot eliminate far-reaching secondary effects of coal utilization. These must be incorporated into comprehensive regional planning. Such planning will have to deal with proposals for electric generators and conversion plants and their attendant environmental problems. Meaningful planning will have to be based on a thorough understanding of the regional meteorology, coal chemistry, effects of emissions on range vegetation and wildlife, water availability, and projected population pressures. This basic information, necessary to determine the composite impact of steam-electric generators and conversion plants, has not been collected, although Montana State University is currently surveying the meteorological conditions at Colstrip. The environmental implications of coal development are covered in Chapter IV under staff investigations.

The more heavily wooded northern portion of the Pine Parklands has attracted out-of-state land developers. Subdivision of approximately 20,000 acres south and west of Roundup is presently underway. The environmental impact of this development has been severe. The majority of the subdivided land has not been surveyed for accurate delineation of property boundaries, thereby evading health department regulations for water supply and sewage treatment. Some of these tracts are inadequate in both instances. At one site, residents of three trailer homes carry water by hand from an open spring, flush toilets with pails of water, and discharge the effluent into an open ditch leading toward the creek. Beyond these considerations, comprehensive land use planning and zoning have been absent. A number of shacks have been built out of rough lumber, slabs, plastic, and old tin. A small down payment and low monthly payments have attracted low-income families seldom able to find employment. This has caused some abandonment of homesites. In addition, numerous poorly designed, hastily built access roads have created esthetic and erosional problems.

Although forests make up a small percentage of the subregion's total land, logging near Roundup and Ashland, has left its mark. In both areas a good deal of timber is privately owned, lacking any control on sales or logging techniques. In some instances near Ashland patches of private timber have been clearcut to rid the land of trees and increase its value for domestic livestock. Selective cutting has been the harvest method used on national forestland. Logging is not yet a widespread problem, but it has had a local impact on water, air, soil, vegetation, wildlife, and esthetics.

Low population densities, good ventilation, and a lack of pollution sources to date have maintained high quality air throughout the subregion. Although air quality has not been extensively monitored, the implementation plan for control of air pollution (2) states that certain rural areas with no industry and little farming probably have a suspended particulate concentration of less than 30 ug/M^3 (micrograms per cubic meter). None of the "hot spots" outlined by the implementation plan occur in this subregion. Burning in unapproved incinerators and community dumps at Busby and Lame Deer were the only violations of state air quality regulations reported in 1970 (3). Two small tepee burners are operating in Ashland and Lame

Deer but are evidently causing few problems. Sulfur dioxide concentrations fall well below the federal ambient standard of 60 ug/M³. Dust from transportation on unpaved streets and roads as well as logging and mining activities probably constitute the most significant air quality problem in the Pine Parklands.

Heavy construction has caused some local ecosystem disruptions. At present the activity is limited for the most part to highway construction, the impact of which depends primarily on the terrain and proximity to streams. Construction of Montana Power's steam-generation plants at Colstrip has begun, and if current projections hold true there will be a great deal of similar activity in the near future.

Recent health department statistics do not indicate any significant contamination of either surface or groundwater supplies in the subregion. Lagoons provide secondary treatment of waste for 90 percent of the sewered population, the remaining 10 percent use Imhoff tanks. Some municipal supplies show a few contaminants, but all are well within allowable limits. Groundwater provides the domestic water supply in all cases, and though consistently rich in sulfate and bicarbonate, it is generally pure in terms of biological contamination.

At Decker, where the coal bed is also the aquifer, strip mining threatens to alter groundwater level, movement, and recharge. A well near the test pit lost five feet of head when excavation began, and preliminary evidence suggests that the aquifer will be drained in that area as mining progresses, drying up many of the local wells. Spoil permeability may be less than that of the coal bed, thus termination of mining activities and subsequent filling of the final cut could form a partial groundwater dam that would impede horizontal movement and cause a pronounced difference in the level of the water table on both sides of it. The spoils could also serve as a local zone of recharge.

Large scale, uncontrolled industrial development of the coal resource would destroy a way of life in the Pine Parklands. To accommodate projected development in the subregion, the clean, dry air might be degraded to a level similar to that of our industrial neighbors, the rivers taxed to the limit, and the "golden" land turned bottom side up. This need not happen. If the problems are anticipated and planned for prior to development, they can be mitigated. If all social and environmental values are properly considered, the public may choose to prohibit development in certain areas. If not, the rural western population of the Pine Parklands and other parts of the Fort Union Basin will pay the full costs of "progress."

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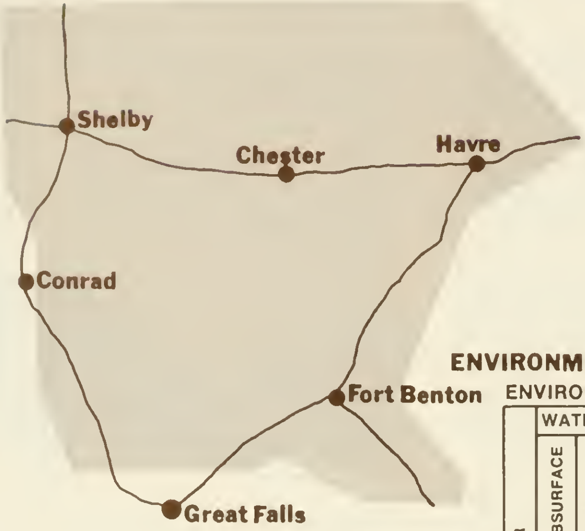
SWEETGRASS PLAINS



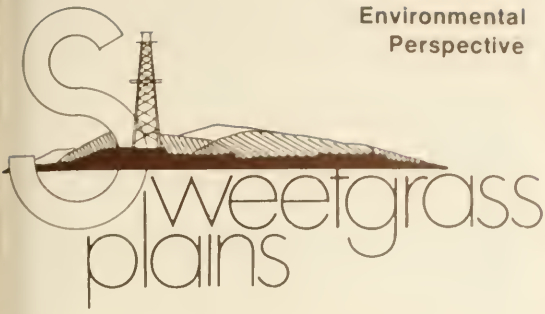
ENVIRONMENTAL IMPACT MATRIX

ENVIRONMENTAL CLASSES

		WATER				BIOTA		
	AIR	SUBSURFACE	SURFACE	SOIL	VEGETATION	AQUATIC LIFE	WILDLIFE	ESTHETICS
DRYLAND FARM.	●	●	●	●	●	●	●	○
GRAZING			●	●	●	○	●	
PETROL. PROD.		○		○	○			○
PETROL. REF.	○							○
RESIDENTIAL	○	○	●	○	○	○		○
TRANSPORTATION	○			○	○		○	○
COMMUN. & UTIL.				○	○			○
WATER STORAGE			○	○	○	○	○	○
RECREATION				○	○		○	○

○ MINOR
● MAJOR

Environmental Perspective



Sweetgrass plains

> ... this giant spread of land, this plain ... Everywhere but to the mountained west it flowed forever. Farther than a man could think, beyond buttes blued by distance, floating in it, the earth line lipped the sky. And hardly anything, any living thing, to see ... just emptiness and open sky. Air like tonic, days like unclaimed gold. And grass and grass and grass. Grass beyond the earth line, which wasn't any line but just the farthest reach of eye. World without end .... (5).

From the Highwood Bench to the Sweetgrass Hills, from Shelby to Havre, from wherever you stand to infinity, stretch the plains of this region. Nothing obstructs the view, little clutters the mind and senses but wind and sky, sun and grass.

The Sweetgrass Plains encompasses historic Fort Benton, head of steamboat navigation on the Missouri and center of commerce for Montana Territory. Portions of the Missouri, Teton, Marias, and Milk Rivers traverse the region, their breaks and bottomlands inhabited by deer and other wildlife. The plains between the rivers are the home of antelope and kindred prairie animals. Tiber and Fresno Reservoirs are large impoundments used extensively for water-based recreation and produce the environmental impacts attendant to such developments. Two national wildlife refuges and two state recreation areas also provide for public outdoor enjoyment and conservation of wildlife resources. The monotony of the plains is broken by the improbable emergence of the Sweetgrass Hills, Rocky Mountain outliers whose cones and ridges mark the horizon of Canada directly to the north.

Ninety-two percent of the surface area of the Sweetgrass Plains is devoted to agriculture (11). The region is one of Montana's finest for wheat production, and alternate strips of wheat and fallow land, designed to conserve soil and moisture, dominate the landscape. Fifty-five percent of the agricultural land is cropland in tillage rotation (11).

The large blocks of cropland and range competition with livestock have restricted suitable wildlife habitat in the region. Problems associated with management of cover, feed supplies, and water for fish, game birds, and animals have been rated severe by agriculturalists (10). Although deer-fawn production is fair to good, suitable habitat is scanty and browse conditions fair to poor and declining where surveyed (8). The only sizeable and suitable deer habitat appears to be the Sweetgrass Hills. The region's one game management area, Tiber, encompasses 10,485 acres in Toole and Liberty counties.

Naturally, other forms of wildlife have felt the pinch of intensive large-scale agriculture. In the Sweetgrass Plains, the status of prairie animals such as the probably extinct northern swift fox, the endangered black-footed ferret and peregrine falcon, and the rare prairie falcon is currently unknown. Breeding bird survey data collected on a route near Sunburst over the last four years (1968-1971) indicate a consistent and reasonably healthy avian diversity, ranging from a minimum of 27 species tallied in 1968 to a maximum of 34 in 1969 (3). The Sunburst route, however, is on the western flank of the Sweetgrass Hills and removed from the area of most intensive farming.

Wildlife conditions are only one reflection of the effects of large-scale agriculture. Montana, most notably in the Sweetgrass Plains, is experiencing an alarming increase in saline seep, a problem directly related to the fallow system. The moisture-conserving capacity of this system has surpassed expectations. Coupled with a geological situation where permeable soil lies over glacial till overlying a thick, impervious shale formation, moisture retention has resulted in a soil profile saturated with highly saline water. Water intercepted by the fallow ground, mostly during the spring months, moves rapidly through the soil profile, accumulating salts along the way, and builds up on top of the shale, forming a "perched" water table. This excess water moves downslope, accumulates in swales, and eventually breaks out at the surface, where it evaporates and leaves the dissolved salts behind. To date, an estimated 250,000 acres of Montana's agricultural land have been lost to saline seep, and the seep area is now growing at a rate of over 10 percent per year (7). Approximately 228,000 square miles of land in the northern Great Plains of the United States and Canada have the potential (geologic regime and fallow dryland farming practices) for saline seep development.

Although saline seeps are most prevalent in the Sweetgrass Plains, particularly on the Highwood Bench and in the Loma and Power-Dutton areas, they have also been reported in the Glacier and Beartooth Foothills and the Two Rivers regions. Their development is not limited to high precipitation areas; large outbreaks have been observed where average annual precipitation is less than 12 inches, including portions of the Sweetgrass Plains. Saline and alkali soil problems are rated very severe throughout the region and present a serious threat to continued soil productivity (10).

Saline seeps not only threaten agricultural land but threaten groundwater and surface water quality. Seep water, which contains more dissolved salts than sea water, is increasingly finding its way into underground aquifers, streams and reservoirs that make up these sources for human, livestock, irrigation, and fish and wildlife use. Seeps are beginning to discharge regularly into Missouri River tributaries, causing degradation of downstream water quality. A typical groundwater sample taken from a flowing well near a small saline seep on the Highwood Bench indicated that manganese, lead, silver, sulfate, choloride, nitrate, and total dissolved solids were in concentrations exceeding U. S. Public Health Service drinking water standards and that quantities of dissolved solids, magnesium, sodium, and lead surpassed recommended stockwater standards (7). Most reservoirs on the Bench were once filled with fresh water, but now practically all are saline; concentrations of total dissolved solids regularly exceed irrigation and stockwater standards and surpass the salinity tolerance of freshwater fish. In addition, high nutrient levels (nitrates and phosphates) have created eutrophic conditions in all the small ponds and reservoirs in the area (7).

Continuous cropping and establishment of a sod cover over the land have been proposed as solutions to the saline seep problem, but neither appears feasible. In areas of low precipitation where conservation of soil moisture is a necessity, and with present overproduction and federal acreage allotments, continuous cropping is out of the question, nor has it proven effective in limiting the problem. Reseeding to grasses and reverting to a livestock-range economy has been proposed because a sod layer would enhance runoff and evapo-transpiration and retard infiltration into the soil profile. If implemented, this would mean a serious financial loss to most farmers, since land suited for more intensive production would be used in a manner far short of its economic value and potential. Moreover, with water quality in its present condition, suitable stockwater would be unavailable from either the ground or reservoirs.

Salinity and fertility problems are not the only ones plaguing agriculture in the Sweetgrass Plains. Water and wind erosion problems are rated very severe and the sediment problem severe (10). Of the total cropland acreage in the four core counties of Chouteau, Hill, Liberty, and Toole, about half is in need of treatment (11). The pasture and range of these counties, amounting to 45 percent of the total agricultural land, is excessively overgrazed; 72 percent needs treatment, mostly (56 percent) in the form of protection only (11).

Agricultural sediment has contributed significantly to turbidity levels in the Sweetgrass Plains, which exceed state water quality criteria in the Missouri River above Fort Benton and the Milk River below Havre (4). With five percent (20,641 persons) of the state's sewered population, the Sweetgrass Plains has one of the lowest rates of secondary sewage treatment in the state. Statistics indicate only 46 percent of the sewered population is served by secondary wastewater treatment, the remaining 54 percent, mainly from the city of Havre (population 10,558), whose sewage is discharged into the Milk River, is served by primary treatment only. Havre is scheduled to initiate secondary wastewater treatment by 1974, in addition to the present mechanical clarification process. (The small community of Sunburst — population 604 — uses septic tanks but expects to have secondary treatment by 1977.) The turbidity problem and the excessive coliform numbers in the Milk River below Havre have prompted the Environmental Protection Agency to list Havre and its environs as the fourth most severe water quality problem area in Montana (4).

Air pollution from residential sources is of minor consequence in the region; the four major communities have either approved landfill disposal (Havre, Shelby, and Chester) or no open burning but infrequent covering (Fort Benton). Although the stockyards and a postyard in Havre have been the objects of citizen complaints relating to odors (9), and the miles and miles of unpaved roads and streets are undoubtably significant sources of blowing dust, air quality is generally excellent, with no recognized "hot spots" or contaminants with high cleanup priorities.

The economy of the Sweetgrass Plains, like that of the following Two Rivers region, is based primarily on wheat and petroleum. In both regions, however, oil and gas exploration, recovery, and refining activities impose a relatively minor environmental impact in comparison to agricultural pursuits. Secondary recovery operations have not had a major effect on groundwaters, and surface waters no longer appear to be subject to contamination from highly saline drilling wastes. The most telling reminders of visitation by drilling rigs are the denuded soils and the trash left behind after operations have closed down (3). Drilling companies should be required to clean up and reseed inoperative sites. Only one refinery, Big West Oil Company at Kevin, operates in the region. This plant is in doubtful compliance with the "sulfur in fuel" regulation and the "petroleum storage" regulation pertaining to hydrocarbon emission enforced by the Department of Health and Environmental Sciences (9).

Impacts from human activity on the environment of the Sweetgrass Plains are primarily agricultural. Industrial or engineered ecosystems have replaced the "grass beyond the earth line." Unlike natural ecosystems, which renew themselves through natural cycles, high-yield monocultures require enormous artificial inputs of energy in the form of fossil fuels, fertilizers, and pesticides.

The Sweetgrass Plains, in microcosm, typifies a worldwide situation: between 1951 and 1966, a 34-percent increase in world food production was attained by increasing annual expenditures on tractors by 63 percent, on nitrate fertilizers by 146 percent, and on annual use of pesticides by 300 percent (6). For each 3,000 calories of food produced, about 7,000 calories of fossil fuels are burned in farm machinery and another 14,000 calories are expended in the marketing process (2).

Agricultural problems will prevail in the Sweetgrass Plains to a greater or lesser degree as long as such an extensive area is manipulated for crop and livestock production. Here the "world without end" has been transformed into a life support system whose finiteness is well within "the farthest reach of eye."

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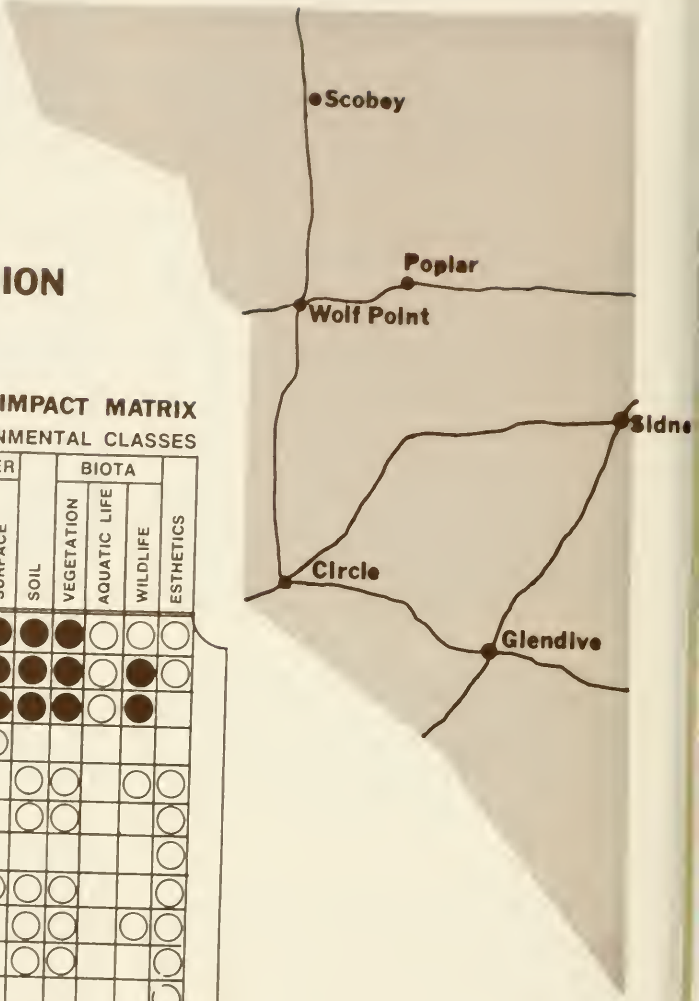
TWO RIVERS REGION



ENVIRONMENTAL IMPACT MATRIX

ENVIRONMENTAL CLASSES

		WATER			BIOTA			
	AIR	SUBSURFACE	SURFACE	SOIL	VEGETATION	AQUATIC LIFE	WILDLIFE	ESTHETICS
IRRIGATED FARM.	○		●	●	●	○	○	○
DRYLAND FARM.	●	○	●	●	●	○	●	○
GRAZING	○		●	●	●	○	●	
AGRIBUSINESS	○		○					
MINING				○	○		○	○
PETROL. PROD.		○		○	○			○
PETROL. REF.	○							○
RESIDENTIAL	○	○	○	○	○			○
TRANSPORTATION	○			○	○		○	○
COMMUN. & UTIL.				○	○			○
THERMAL POWER GEN.	○							○
RECREATION				○	○		○	○

○MINOR
●MAJOR

Two rivers

Environmental Perspective

The two rivers, the Missouri and its first major tributary, the Yellowstone, converge across Montana from the west and southwest to their confluence near the present northeastern border of the state. These waterways were vital avenues for exploration of the early-nineteenth-century frontier and for nearly 100 years thereafter for settlement and commerce. Captain Lewis recorded his impressions of the area on April 25, 1805, shortly after the Corps of Discovery passed the mouth of the Yellowstone on its westward journey:

> **. . . The country on both sides is much broken, the hills approaching nearer to the river and forming bluffs, some of a white and others of a red color, exhibiting the usual appearances of minerals, and some burnt hills, though without any pumice stone; the salts are in greater quantities than usual and the banks and sandbars are covered with a white incrustation like frost. The low grounds are level, fertile, and partially timbered, but are not so wide as for a few days past. The woods are now green, but the plains and meadows seem to have less verdure than those below . . . Game is very abundant — the common, and the mule or black-tailed deer, elk, buffalo, antelope, brown bear, beaver, and geese. The beaver have committed great devastation among the trees, one of which, nearly three feet in diameter, had been gnawed through by them (1)**

To the first explorers of what is now the state, the Two Rivers region was a proper introduction. Although lacking the grandeur and relief of other regions, the country astride the Missouri on that spring day in 1805 presaged the openness, the stark beauty, and the diversity of form and hue that is Montana.

The stage was set millennia ago when the great ice mantle of the Wisconsin glaciation covered the northern prairies. The ice redirected the course of the ancestral Missouri River and in its wake left a broad, rolling landscape, blanketed by a veneer of glacial debris. Over half of the Two Rivers region was so affected.

Weather patterns influenced by the Rocky Mountain chain to the west dictated that grass in solid profusion should grow on the rich soil developed over the glacial till as part of the expansive North American grassland biome. The grass furnished a livelihood for immense herds of ungulates — elk, bison, pronghorn antelope, and deer — and provided the basis for a primitive hunting culture that persisted until the nineteenth century.

Except for agricultural practices, man to this day has not had a great impact upon life support systems of the region, as indicated by the environmental impact matrix for the Two Rivers.

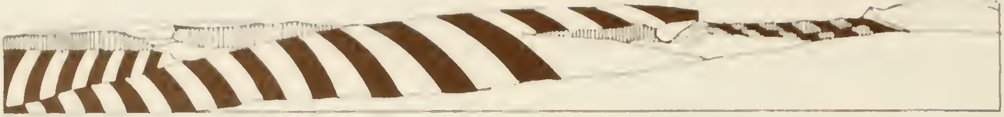
The nomadic aboriginal Plains Indian lived in harmony with the land, harvesting bison only out of need and occasionally setting the prairie grass afire, both for hunting and for stimulating the succulent spring regrowth. Later, the great fur companies of the early nineteenth century — Hudson's Bay, Northwest, Rocky Mountain, and particularly in this corner of Montana, American — were influential enterprises but left scarcely a mark upon the land except for the temporary depletion of the beaver and other fur bearers.

Following the western Montana gold rush of the 1860's, Texas cattlemen grazed their trail-weary longhorns on the prairies between the two rivers, remaining below the Missouri because of hostile Indians and lack of suitable range to the north. The cattle gradually replaced the bison until the last great herds were finally decimated in the 1880's by many hunters, hide hunters, "sportsmen," and the reservation-starving bands of Indians. With little competition from native grazers, the longhorns flourished until the severe winter of 1886-1887, which sounded the death knell for the open-range cattle empire of eastern Montana. With the aid of supplemental winter feeding and intelligent management, most large-scale operations, including Pierre Wibaux's W, continued to thrive but the industry was crippled and entered the twentieth century [illegible].

Two transcontinental railroads crossed the Two Rivers region, and with them came hordes of homesteaders. This era put the environment to its severest test. The great ranges were fenced, and thousands of acres of prairie sod were turned wrong-side-up and sown to small grains. Unpredictable precipitation resulted in boom-or-bust agriculture on the ridiculously small parcels of land the government allotted, forcing farmers to rely on larger and larger acreages to balance [illegible] against the vagaries of climate and the lean years. The population and number of farms dwindled, but the average farm size grew and larger and larger segments of the prairie were devoted to monoculture.

Such intensive and extensive farming, coupled with severe and recurring droughts on into the 1930's, resulted in severe ecosystem instability, soil and fertility losses, and [illegible] problems. These have been partially mitigated through modern dryland farming techniques and management promoted by state and federal agencies.

Recreational opportunities are limited in the Two Rivers. Although the region contains many fishable lakes and reservoirs, only four flowing waters, the Missouri and Yellowstone Rivers, the Poplar River, and Wolf Creek, are considered to have fishing values to any considerable extent. These waters are classified as Class 4 streams of value only to [illegible] such as [illegible]. The Fish and



Game Commission has purchased or leased seven fishing access sites totaling 263 acres of land, mostly on small reservoirs

For the hunter, the open prairies, river bottoms, brushy draws, and wetlands produce a variety of game birds and mammals. The U. S. Fish and Wildlife Service administers two national wildlife refuges in the Two Rivers — Medicine Lake (22,824 acres) south of Plentywood and the much smaller Lamesteer near Wibaux. The Montana Fish and Game Commission controls an additional two areas for game management — Johnson Reservoir (68 acres) and Fox Lake (1,362 acres). The Department of Fish and Game maintains Makoshika State Park near Glendive, a 160-acre natural area featuring scenic erosional landforms.

In the Two Rivers, habitat has been drastically altered by intensive agriculture, and some native species are on the rare and endangered list of the Bureau of Sport Fisheries and Wildlife. Rare animals, status unknown, include the pallid and shovelnose sturgeon, black-footed ferret, and northern swift (kit) fox, the last two species probably extinct. The bald eagle is listed as rare and the peregrine falcon endangered and declining.

Over the last four years (1968-1971), spring breeding-bird surveys have been conducted over two routes in the region — Redstone and Savage. The maximum number of species observed on each route over these years was 37 on the Redstone and 30 on the Savage; minimum numbers were 26 and 20 respectively (2, 3). Average avian diversity figures for these routes were comparable to others in Great Plains Montana and have shown no significant downward trends.

Browse conditions for the Two Rivers' substantial deer herd vary considerably. Although fawn production has been good to excellent, browse conditions along the Yellowstone River bottom (hunting district 750) were rated very poor in the latest vegetational survey (5). Hunting districts south of the river were likewise rated poor to very poor, whereas those north of the river had good to excellent browse conditions. Light hunting pressure and surplus animals were cited as reasons for deteriorating browse in the former districts and in the bottomlands. Wildlife management problems (maintenance of cover, food, and water for fish, game birds, and animals) have been rated moderately severe in the region (9).

Greater than 90 percent of the Two Rivers' land area is devoted to agriculture. The six counties forming the bulk of the region, Daniels, Dawson, Richland, Roosevelt, Sheridan, and Wibaux, contain about three million acres of cropland and three-and-one-half million acres of pasture and range. Fifty-four percent of the cropland acreage and 40 percent of the pasture and range acreage in these counties are in need of conservation treatment (12). Thirty-four percent of the range and pasture lands is overgrazed and is categorized as needing protection only.

Dust is a problem throughout the entire region. Many thousands of acres of cropland are fallow the year round and wind erosion of agricultural soils is severe (9). Serious dust-blowing occurs on irrigated Yellowstone Valley lands in the spring as the result of overworking soils with farm machinery (10).

Questionnaires returned by fish and game department field personnel in Districts 6 and 7, which include the Two Rivers region, cite heavy unnatural siltation as the primary chronic water quality problem in the area. Certain agricultural practices were given as the major causes, including overgrazing, improper irrigation practices, and conversion of grasslands to grain crops. Area soil conservation district supervisors similarly recognize water erosion of soils as a severe problem and sediment pollution as moderately severe to severe (9). The supervisors rated the impacts of all other agricultural sources of water pollution as slight to none north of the Missouri River and only moderately severe in the southern part of the region. In addition to problems of wind and water erosion and sediment, those of soil fertility, salinity, and alkalinity were rated from moderately severe to very severe throughout the region (9). Saline seeps, prevalent in the Sweetgrass Plains, are now developing in the Two Rivers for similar reasons based on dryland farming and geology (10).

Degrees of human congestion are often used, inversely, as indicators of the quality of living. In the six core counties of the Two Rivers, human population averaged 3.8 persons per square mile. Urban crowding is nonexistent; the largest town, Glendive, has slightly over 6,000 inhabitants and retains much of the slow-paced character of an agricultural community. Because of the farming-ranching economy, the rural population is quite evenly distributed. Although most services and supplies are not as convenient as they are to western Montanans, dwellers of the Two Rivers and other thinly settled regions have become accustomed to traversing considerable distances for commodities and services. Farmers give little thought to traveling 50 miles one way for groceries or 90 miles for tractor parts and medical services (doctors are in short supply throughout Great Plains Montana) or to send their children 20 miles to school.

Nevertheless, other indicators in the Two Rivers, including high death rates from respiratory diseases, may reflect serious incompatibilities between the human population and its environment. According to health department statistics, Daniels County ranked fourth in the state in five-year death rates (1966-1970) from throat cancer and bronchitis. Among the five other counties situated entirely within the region, Dawson County was in the highest quartile of Montana counties for three-year lung cancer mortality rates (1968-1970), and adjacent Prairie County, in the Big Dry region, ranked number one in the state over that period. Although the relatively small sample sizes may preclude statistical significance, these rankings are included here for future reference.

Hundreds of miles of unpaved county roads add to the region's agricultural dust problem. Streets are unpaved in most small communities, and even in the larger towns many peripheral streets in the newer sections are unpaved and are sources of blowing dust.

Four of the larger communities — Glendive, Poplar, Sidney, and Wolf Point — have approved landfill disposal sites, thus eliminating a significant amount of air pollution from previous open-burning operations. The town of Savage does not burn its refuse but covers it only infrequently.

The environmental impact of nonagricultural industry is currently insignificant in the region. Coal and gravel are the primary mineral resources, but neither have been developed to any extent. The only strip-mining operation, Knife River at Savage, has disturbed approximately 100 acres and reclamation is in progress. Lignite coal, mined at Savage, is burned principally at the Montana-Dakota Utilities (MDU) electrical generating plant at Sidney. No severe inversions occur in the Two Rivers (1); the air is generally in motion, frequently at high velocities. Major sources of air contaminants are few and widely scattered.

The health department's 1970 report (6) lists four air pollution sources in the Two Rivers in counties not previously surveyed. These include Holly Sugar and MDU in Sidney, MDU in Glendive, and Tesaro Petroleum in Wolf Point. As of March, 1972 the pulp driers at the Holly Sugar plant and particulate emitted by the Sidney MDU operation were not in compliance with control regulations. All small refineries in the state, including one at Wolf Point, were in doubtful compliance with the petroleum storage regulation pertaining to hydrocarbon emission as of March, 1972. The Glendive MDU plant uses natural gas as a fuel, and particulate and sulfur emissions are negligible.

The region's water, although alkaline from the ground and infrequent from the clouds, is generally adequate for present needs. Far removed from the principal recharge and snowmelt of the Rocky Mountains, the Missouri and Yellowstone Rivers are high in salts and other dissolved and suspended materials. Local streams are usually intermittent and do not support a sport fishery. In many parts of the region, groundwaters are naturally hard from the salt content of sedimentary aquifer materials, particularly marine shales. Although natural water resources are of questionable quality, little environmental monitoring has been conducted in the Two Rivers.

The U. S. Geological Survey maintains three water quality monitoring stations in the region — two on the Missouri River and one on the Yellowstone. Data from samples collected at these stations show that in 1970 water in both rivers was extremely hard, in excess of 150 milligrams per liter calcium and magnesium (11). The data also indicate the Missouri River water passing through the region is acceptable according to U. S. Public Health Service drinking water standards. In the Yellowstone River at Sidney, however, the sulfate limit was exceeded in seven of 22 samples and the total dissolved solids limit was surpassed in five of nine samples.

Municipal water wells in the region produce waters with consistently high concentrations of total dissolved solids and sulfate (which can have a laxative effect), commonly two to three times the upper limits for drinking water (7, 8). In addition, all well samples in Daniels, Sheridan, and Roosevelt Counties had extremely hard water, and those in Dawson and Wibaux counties were rated from soft to hard. Two wells, both in Fairview, produced water containing concentrations of nitrate in excess of four times the drinking water standard — 180 and 190 mg/l (milligrams per liter). Concentrations above 45 mg/l can cause methemoglobinemia, a malady to which infants are particularly susceptible. As for coliforms, seven percent of the population received unsatisfactory drinking water from public supplies.

The six percent (28,851 persons) of the state's sewered population in the Two Rivers depends almost entirely (97 percent) on lagoons for secondary treatment of its municipal sewage. Bainville and Wibaux, accounting for the remaining three percent of the region's sewered population, are served by Imhoff and septic tanks respectively, providing primary treatment. These communities will receive secondary treatment by 1974.

Although small by comparison with other coal-fired steam-electric stations, the MDU plant at Sidney discharges an average of 11,000 gallons of water per minute into the Yellowstone River. This water is heated an average of 27° F over the ambient temperature of the river water, but the quantity of heated water discharged is not sufficient to violate water quality criteria (14). The Holly Sugar factory began recirculating condensing water in 1971. Flume water for moving and washing beets will be treated by lagoon and recycled in 1972.

The Two Rivers region, along with the Sweetgrass Plains, is Montana's most important petroleum production area. Extraction of petroleum reserves is accelerating, but the pumps are still too few to blight the general landscape. Drilling activities are not known to cause major environmental disruptions. Two small refineries operate in the region and to date have created little disturbance.

Also in common with the Sweetgrass Plains, the inescapable influence of natural forces is felt in the Two Rivers, and in both regions continuous manipulation of these forces through monoculture production threatens the viability of the land. It may not, in the long run, be a land that will accommodate such manipulation. Wallace Stegner has commented on man's tenuous position in a landscape such as that of the Two Rivers:

> **You don't get out of the wind, but learn to lean and squint against it. You don't escape sky and sun, but wear them in your eyeballs and on your back. You become acutely aware of yourself. The world is very large, the sky even larger, and you are very small. But also the world is flat, empty, nearly abstract, and in its flatness you are a challenging upright thing, as sudden as an exclamation mark, as enigmatic as a question mark (11).**

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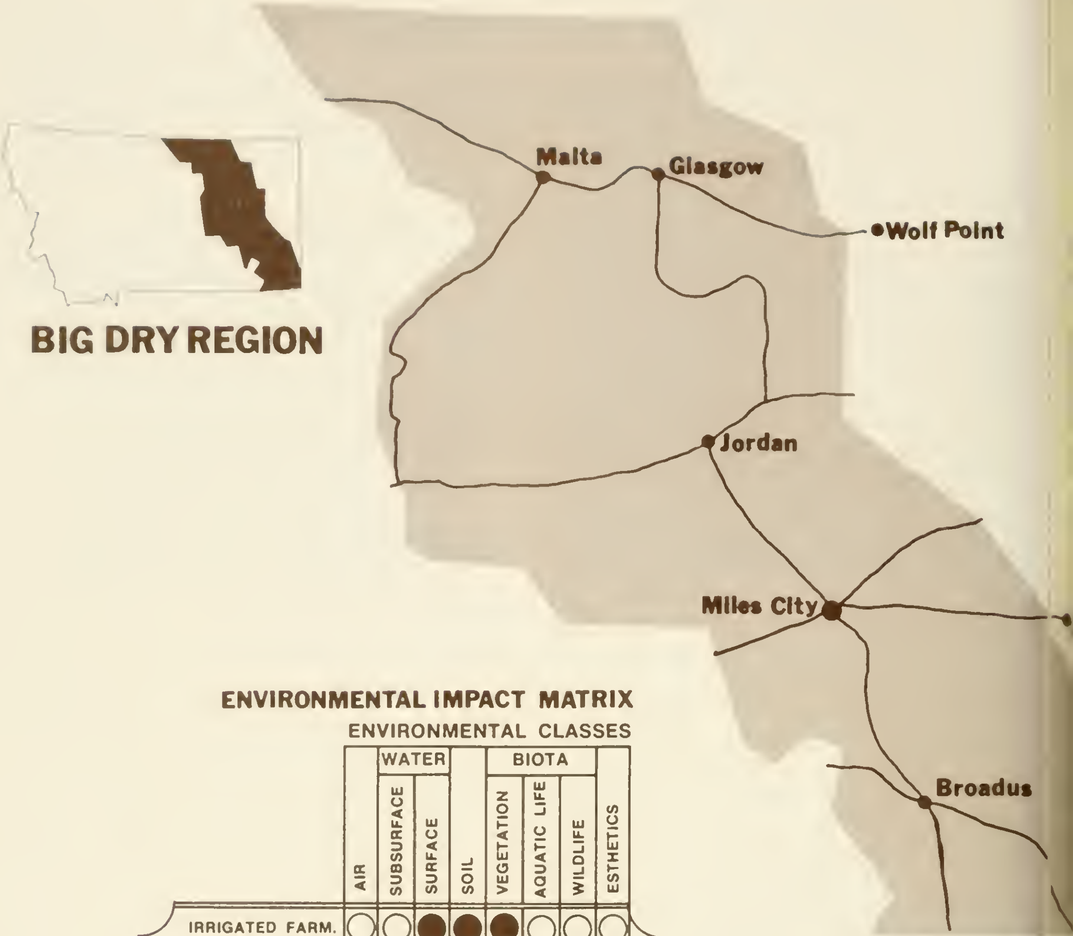

BIG DRY REGION

ENVIRONMENTAL IMPACT MATRIX

	ENVIRONMENTAL CLASSES							
		WATER			BIOTA			
	AIR	SUBSURFACE	SURFACE	SOIL	VEGETATION	AQUATIC LIFE	WILDLIFE	ESTHETICS
IRRIGATED FARM.	○	○	●	●	●	○	○	○
DRYLAND FARM.	○	○	○	●	●		○	○
GRAZING			●	●	●		●	
PETROL. PROD.		○	○	○	○			○
PETROL. REF.	○							○
RESIDENTIAL	○	○	○	○	○		○	○
TRANSPORTATION	○		○	○	○		○	○
COMMUN. & UTIL.				○	○			○
WATER STORAGE			○	●	●	○	●	○
RECREATION			○	○	○		○	○

○ MINOR
● MAJOR

Bigdry

Environmental Perspective

Contrary to promotional propaganda fed to homesteaders, Major John Wesley Powell, the nineteenth-century prophet of western agriculture, clearly observed that:

> **The eastern portion of the United States is supplied with abundant rainfall for agricultural purposes . . . but westward the amount of aqueous precipitation diminishes in a general way until at last a region is reached where the climate is so arid that agriculture is not successful without irrigation.**
>
> **The grass is so scanty that the herdsman must have a large area for the support of his stock. In general a quarter section of land alone is of no value to him; the pasturage it affords is entirely inadequate to the wants of a herd that the poorest man needs for his support (13).**

The Big Dry might have been what some earlyday explorers had in mind when they named that interior portion of western America the "Great American Desert." This part of Montana, however, can be conceived of as a desert only in contrast to the pleasantries and verdure to which our European forefathers were accustomed. Today it remains largely unsettled, even by Montana standards. The average population density for the six core counties of Carter, Custer, Garfield, Petroleum, Phillips, and Prairie is about one person per square mile.

Although subject to weather extremes and handicapped by a shortage of good water, the Big Dry is not an unproductive wasteland. In a sense it is a vast industrial complex, stretching from the Canadian border to the Wyoming line. Thousands upon thousands of factories punctuate the landscape — not drab, gray monoliths of concrete and steel but small, living plants, mostly grasses, and the wild and domestic animals that feed upon them.

The vegetation of the Big Dry — western wheatgrass, big sagebrush, juniper, and others — evolved under the grazing and browsing pressure of a variety of herbivores, most notably bison. The bison are gone, replaced by cattle and sheep, but other wild herbivores existing under the natural equilibrium of prehistoric times remain, though in altered numbers.

By the amazing process of photosynthesis, plants have furnished countless prairie creatures with food, produced primarily from a "waste" gas, carbon dioxide, plus other raw materials. As byproducts of food production they release oxygen and water vapor into the atmosphere, a refreshing change from the usually noxious industrial emissions. For energy, grasses and other forage plants rely upon sunlight, a pervading feature of the prairie environment and a vast and timeless energy source. (Enough sunlight energy falls upon the United States every two days to outlast all our known remaining fossil fuel reserves (14).)

The grasses, shrubs, and forbs of the Big Dry have accomplished what man has failed to do — produce a usable commodity (vegetable protein) from a useless waste (carbon dioxide), utilizing a free and inexhaustible source of energy (the sun), and at the same time emitting byproducts that are not only nontoxic but absolutely essential to our continued existence (oxygen and water).

The Big Dry was originally one of the richest wildlife areas in North America, supporting a wide array of big game, small animal, and bird species. The Bureau of Sport Fisheries and Wildlife (BSFW) and the Montana Department of Fish and Game have set aside numerous refuges and management areas in order to protect and preserve vestiges of the native prairie habitat from livestock grazing pressure. The state agency operates five game management areas in the region, totaling nearly 6,000 acres. The BSFW maintains seven units of the National Wildlife Refuge System, totaling about one million acres. By far the largest of these, and of all refuges across the state, is the Charles M. Russell National Wildlife Range covering 920,000 acres straddling the 125-mile-long Fort Peck Reservoir. The range was established principally for sharp-tailed grouse and pronghorn antelope, but is also managed for other species necessary to maintain a balanced wildlife population, including large numbers of migratory waterfowl that nest and feed along the resesservoir and the Missouri River. The range also provides habitat for mule and white-tailed deer, transplanted elk and mountain sheep, coyote, jackrabbit, desert cottontail, prairie dog, Merriam's turkey, ring-necked pheasant, mourning dove, upland plover, burrowing owl, and rattlesnakes. The black-footed ferret, a former resident, is probably extinct. The mountain plover, another resident, may be rare or endangered but not enough information is available to determine its exact status.

Breeding-bird survey data over the last four years from the eight routes in the Big Dry show the average of 34 nesting species is on a par with bird diversity in the other four regions of Great Plains Montana. Numbers of species observed on each route show no significant downward trends. The minimum number of species observed was 12 on the Powderville route in 1969, the maximum was 52 on the Brandenberg route in 1971 (2).

In the Big Dry, recreational opportunities range from water-related sports on streams and lakes to big game hunting in the uplands. Fort Peck Reservoir offers diversified angling for northern and walleyed pike, channel catfish, goldeye, and rainbow trout. In certain areas snagging for paddlefish, which often reach six feet in length, is popular sport.

Fort Peck is the fourth largest reservoir in the world, with an acreage equal to that of all Montana's lakes combined. Its shores provide many recreational areas for hiking, camping, and boating. The Big Dry contains 10 state parks and recreation areas, six of which are associated with Fort Peck. For the hunter, the C. M. Russell and U. L. Bend National Wildlife Refuges offer upland game birds, antelope, deer, mountain sheep, and elk. Migratory waterfowl may also be hunted in most areas. Elsewhere in the region, deer and antelope are common big game animals, with sage and sharp-tailed grouse and Hungarian partridge heading the upland bird list.

South and east of Ekalaka in Carter County are three outlying portions of the Custer National Forest featuring ponderosa pine parklands and scenic erosional landforms. Here the agency maintains three camp and picnic grounds.

Grazing, the manipulative conversion of plant into animal protein, is the major industry of the Big Dry and the most compatible with the environment, given intelligent management of grazing-evolved natural vegetation. Eighty-five percent of the land area is devoted to agriculture (10). Over eight million acres in the six core counties (90 percent of the privately owned agricultural land) is range and pasture (16). Federal lands are grazed by domestic livestock, as are portions of large tracts reserved for wildlife habitat.

Range ecosystems of the region vary from those consisting almost entirely of diverse native plants managed by more or less ecological methods, such as rest-rotation, to others in which species diversity has been reduced through plant control, revegetation, or other manipulation and where land is managed on an agronomic basis by irrigation and fertilization.

Grazing is intended to be in equilibrium with the annual production of forage to produce an optimum sustained annual yield of domestic animals and, especially on public lands, wildlife. Confinement of domestic livestock in large numbers in fenced pastures usually results in high yields of livestock products at first. Continued overgrazing results in deterioration of vegetation, microclimates, microfauna and flora, and soil. In 1878 Powell foresaw that plains grasslands needed careful management, anticipating that overgrazing would turn them into desert (13).

Overgrazing is especially harmful in the Big Dry, where soil and parent materials are highly susceptible to runoff and erosion. These problems are rated severe to very severe throughout the region by soil conservation district supervisors (11). The highest stream-sediment yields in Montana (over 500 tons per square mile) are in Phillips, Blaine, Valley, and parts of Fergus, Petroleum, and Garfield Counties, (9). The sediment problem here is rated moderately severe to severe (11).

Deterioration of both deer and livestock forage has been well documented throughout the region. Forty-six percent of the pasture and range acreage of the six core counties is in need of treatment, ranging from protection to reestablishment of vegetative cover (16). Most of those lands needing treatment (about 75 percent) require protection only, indicating overuse beyond the capacity of forage plants to regenerate aerial parts. Deer-browse conditions have been generally poor over the last few years, although fawn production has been fair to excellent (6). Deer production and pressure on preferred browse plants, particularly juniper, are regulated largely by spring moisture and the duration and severity of winter weather. When rainfall is ample, deer feed on succulent herbaceous plants in preference to juniper. In winter and when rainfall is scant, they turn exclusively to the woody browse species and may cause hedging. A plant, like an animal, can take only so much abuse before vitality is impaired and production ceases. Wildlife problems attributed to grazing in the Big Dry are rated as moderately severe to severe (11).

Soil Conservation Service personnel, ranchers, and others feel a need to "improve" rangelands by "sagebrush control," euphemisms applied to the ecologically unsound practice of eradicating sagebrush over large tracts of land by aerial spraying with the poison 2-4 D. "Cows can't eat sagebrush and grass can't grow where sagebrush grows, so get rid of it!" is accepted rural logic throughout much of Montana's range country. The problem is that some wildlife species, notably antelope, mule deer, and sage grouse, need sagebrush for survival.

Sagebrush control, however abundant the plant may be, is not as prevalent in the Big Dry as it is elsewhere in the state. The six core counties, accounting for perhaps 60 percent of the region's total land area, contain nearly a third (1,714,000 acres) of Montana's lands dominated by big sagebrush (acres with more than 15-percent relative coverage by weight). On the other hand, only about 20,000 acres have been controlled to date, compared to nearly 700,000 acres statewide (15). Sagebrush controlled with assistance from USDA cost-share programs over the most recent years for which records are available shows a downward trend across the state: 69,373 acres in 1966, 57,521 acres in 1967, and 49,703 acres in 1968 (15).

Range managers assert that sagebrush infests overgrazed grasslands and displaces more desirable plants unable to compete with the unpalatable intruder. However, eradication of sagebrush invasions only side-steps the more basic problem of overuse.

The Bureau of Land Management has initiated a healthy program of allotment management plans for grazing operations involving public land in need of treatment. The plans are designed to utilize the principle of rest-rotation grazing. Rest-rotation relieves the pressure on vegetation, restores vigor, maintains plant cover, density, and diversity, and enhances seed production. The program's two primary objectives are wildlife habitat and watershed improvement. Approximately 1,200 ranches in Montana and North Dakota qualify for management plans, but only 175 have been written and 150 implemented, with only five to 10 additional plans written per year (5). About 80 plans have been implemented in the Big Dry (17).

A little over half a million acres or 10 percent of the agricultural land of the six core counties is cropland. The Big Dry is marginal for dryland farming. Fifty-seven percent of its cropland, mostly nonirrigated, requires conservation treatment, particularly to mitigate moisture loss and wind and water erosion (16). Moisture conservation and wind erosion problems are rated severe to very severe across the region; fertility, salinity, and alkalinity problems are also severe (11).

Irrigated cropland is confined primarily to the Milk River floodplain, with a lesser but significant amount along the Yellowstone. Perhaps it is not coincidental that the Milk River is the only stream in the region not in compliance with state water quality criteria. For a distance of 180 miles between Havre and its confluence with the Missouri, the river carries water that is excessively turbid (above what it is naturally) and laden with bacteria (3). Although Havre is not in the Big Dry, its primary sewage effluent undoubtedly contributes to downstream water quality degradation; however, the excessive turbidity is primarily from improper farming and irrigation practices and the bacteria are from feeding operations along the river (12). Glasgow, on the lower end of the Milk, is rated the sixth most severe water pollution zone in the state by the Environmental Protection Agency (EPA) (3).

Water storage projects, especially Fort Peck, have had a major impact on the soils, vegetation, and wildlife of the region. Nearly a quarter of a million acres of upland range and riverbottom wildlife habitat were flooded during the reservoir's filling in the late 1930's. The floodplain ecosystem along the Missouri was completely obliterated for a distance of 135 miles and replaced along 1,500 miles of shoreline by sterile mudbanks created by fluctuating water levels. Numerous stockwater reservoirs punctuate the Big Dry and have similar impacts but on a much smaller scale.

With no monitoring information available, air quality in the Big Dry is not precisely known. The region coincides largely with the Miles City air quality control region of the Department of Health and Environmental Sciences. No "hot spots" have been identified and all pollutants have been assigned the lowest cleanup priority. Monitoring has been scheduled but not yet initiated at two stations in Miles City, although EPA estimates for the community indicate that both suspended particulate and sulfur oxides are below the federal secondary standards (8).

With hundreds of miles of unpaved roads and streets, and with numerous uncontrolled point sources of emission, such as burning dumps and incinerators, dustfall and suspended particulate may be excessive in many of the communities not yet studied. To date only Glasgow, Miles City, and Malta have approved landfill disposal sites. Another, Chinook, does not burn its waste but covers it infrequently. Eight violations of Montana air pollution control regulations, six in the Miles City area, were listed for the Big Dry in the 1970 report (7). Air pollution from agricultural sources may also be significant, although probably not as important as in regions of more intensive dryland and irrigated farming.

Several counties in the Big Dry rank high in death rates caused by respiratory disease according to health department figures. In five-year death rates (1966-1970), Phillips County ranked second in the state in throat cancer and emphysema, Petroleum fourth in emphysema, Musselshell second and Blaine third in bronchitis. For three-year lung cancer mortality rates (1968-1970), Prairie County ranked first, Garfield fourth, and Powder River fifth, while Blaine, Phillips, Custer, and Valley Counties were in the high and medium-high quartiles computed for all counties across the state. No adequate explanation exists for such unreasonably high death rates. Small sample and population sizes may preclude statistical significance for some counties.

The Big Dry contains seven percent of the state's sewered population. Ninety-nine percent of the region's sewered population is served by the equivalent of secondary treatment, mostly lagoons, while only one percent (400 people in Hinsdale) is served by primary (septic tank) treatment. By 1974 all sewered communities should have secondary treatment facilities.

Eighty-six percent of the population served by public drinking water supplies in 1971 was delivered satisfactory water in terms of coliform numbers. Water from several of the municipal supplies exceeded U. S. Public Health Service standards, particularly in total solids and sulfate (10). Most municipal wells in the Big Dry deliver extremely hard water.

One potential development with serious environmental impacts deserves mention. The Fort Union Basin lies within the Big Dry as well as within the Pine Parklands. The varied impacts of strip-mining coal and generating power in this basin are discussed in Chapter IV. Another development, petroleum production in the Bell Creek field, has existed for some years, extraction of newly discovered reserves in this field and secondary recovery projects in the Baker area will probably be of short duration.

In our environmental perspectives for Great Plains Montana we have focused on the special amenities possessed by each region, the significant environmental impacts, and the indicators of environmental quality. But there is more to the prairie country than campgrounds and parks, saline seeps and depleted range, coliforms and dust. There are

> **Names and places, and things no words could tell. Spring in Montana. Summer. Fall. The look of ranges, bench on bench. The month of the wild rose. The time that cactus flowered.**

Everywhere the grasses straight or blowing. Cows and calves, and all the fat earth for a pasture. The chinook, out of its mother cloud over the mountains. The feel of winds. Winter, even, and the tonic feel of cold. The sky. Always the sky (4).

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Conclusion

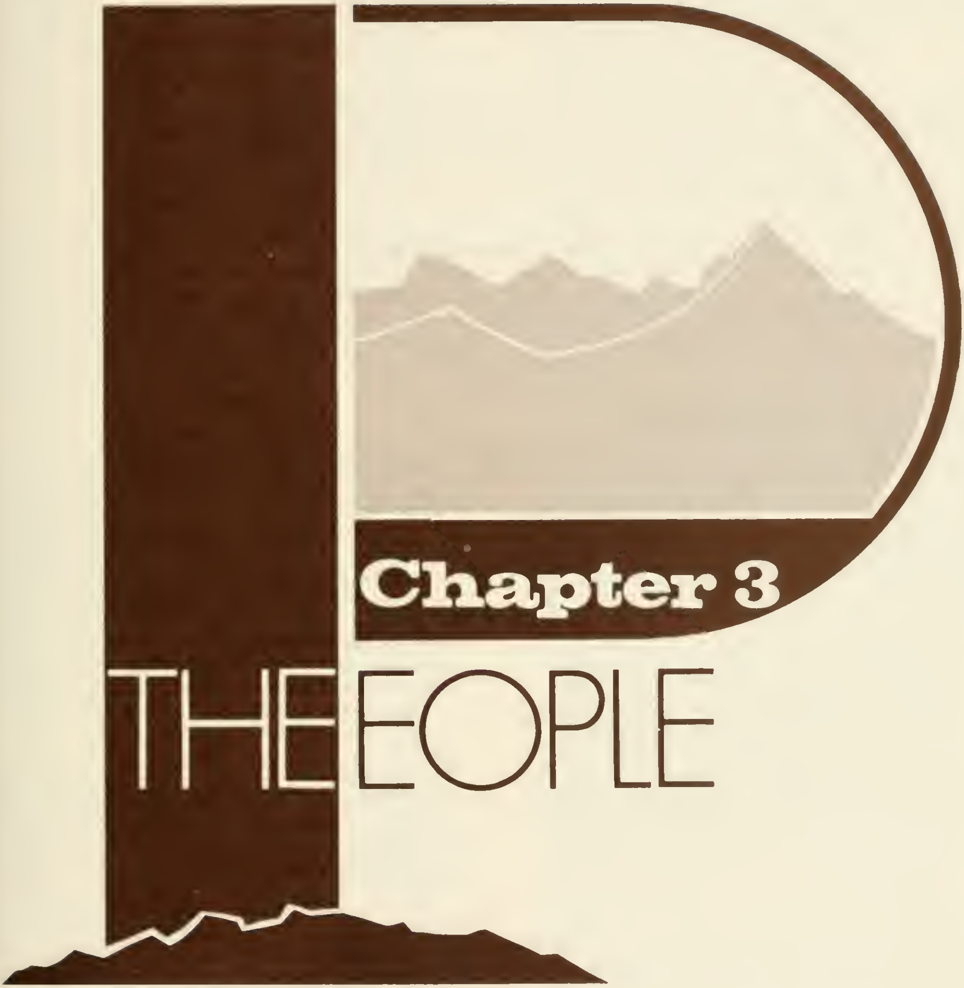
Components of the environmental regions interact to form the larger geographic entity — Montana. Water from the Yellowstone Rockies irrigates the fertile farmlands of the Beartooth Foreland and will be a major factor in coal development in the Pine Parklands and Big Dry. Beef cattle from the Big Dry go to finish out in the feedlots of the Beartooth Foreland. Timber from the Columbia Rockies is manufactured into wood products in the Broad Valleys. Electricity generated in the Columbia Rockies powers mineral processing in the Broad Valleys. Man-made interlocks of transportation and utility systems are added to such natural inter-ties as the hydrologic system. Over all is imposed the political system which does not relate to environmental classes.

The environmental perspectives and quality indicators discussed in this chapter are intended to serve primarily as baselines for comparison with future information. Already certain trends are identifiable. These promise to alter two factors that have long protected much of Montana's environment from the impacts of rapid development experienced by more populous states — lack of investment capital and distance from markets.

It seems likely that a major trend in Montana's future will be energy production from her natural resources, particularly coal (see Chapter IV). Exploration for oil, gas, and uranium will also continue. A second major trend is land development, both urban sprawl and speculative second-home and recreational ventures. Both trends generate large inputs of out-of-state capital and expanded transportation systems. The old protective factors will no longer be effective, and unless controls are applied, Montana's future will be decided in centers of commerce and government elsewhere.

Agriculture is Montana's leading industry and the framework for its life style. Large-scale coal development can disrupt much eastern Montana agriculture because in many cases surface rights are separate from mineral rights and because the coal industry can successfully compete with farmers and ranchers for use of available water. The other trend, land speculation, has driven the price of land near cities and in areas with excellent environmental amenities far beyond any possible monetary return from agriculture and has broken up many productive units. It is difficult to make a case that in the long run such trends are good for Montana's agrarian economy and culture.

If the quality of life that Montanans know now is to be maintained, intense citizen effort must harness these trends in the future. Industries and government agencies must foresee the long-term consequences of their actions and learn the necessity of working with nature instead of against her. It will be easy to mistake higher standards of consumption for improvements in the true quality of life. In the words of Sydney Howe, "Environmental leadership . . . must rise to advance every man's living condition by showing the way to a prosperity that is at peace with natural and man-made systems."



Chapter 3

THE PEOPLE

Introduction

This chapter is a discussion of some of the main actors in Montana's environmental arena. The 1971 legislature showed increased concern about environmental quality and enacted a number of significant measures. Even though the state's revenue problems occupied a good deal of the session's time and debate, the environmental record of the 42nd Assembly is a clear improvement over preceding sessions.

In 1972 a constitutional convention met to revise Montana's 1889 Constitution. Several provisions of environmental import are contained in the new document but the delays caused by a legal dispute over its ratification precluded coverage in this report.

No review of the groups involved in environmental quality decisions would be complete without discussion of the efforts of persons who do not hold legislative or administrative office. Citizens, individually and in groups, foster the healthy commotion that improves the visibility and quality of governmental decisions.

The chapter also contains papers contributed by three of the state's major industries: agriculture, petroleum, and wood products. Efforts to obtain a discussion of the environmental protection activities of the mining and metallurgy industry were unsuccessful. This important industry and others will be covered in future reports. The contributed papers do not represent the position of the Environmental Quality Council or its staff.

The 1971 Legislature
New Environmental Law and Its Implementation

Although the 1971 Montana Legislature was plagued with unyielding fiscal problems, one of its primary preoccupations was the quality of the natural environment. As Don Aldrich of the Montana Wildlife Federation wrote in a recent issue of the *Montana Business Quarterly:*

> Resource responsibility, environmental conscience, and an ecologically sound philosophy were demonstrated by the way Montana's 42nd Legislative Assembly passed laws to lend order to mineral development, prevent pollution, and manage wildlife that has been heretofore considered man's enemy. Carryover environmentalists and freshmen legislators with concern for quality living combined their efforts to give Montana's 42nd legislative session new distinction in providing controls for resource management and development (1).

The concern of the 1971 legislature was set forth in a number of resolutions, which are basically expressions of legislative sentiment and support. House Joint Resolution 32 urged an amendment to the state constitution to permit the Board of Land Commissioners to classify state lands under the multiple use concept. SJR 5 supported Senator Metcalf's bill to establish a Missouri Breaks Scenic Recreation River from Fort Benton to Robinson Bridge. SJR 23 endorsed wilderness designation of the Lincoln Back Country and the Scapegoat Mountain area. House Resolution 24 was a shoo-in resolution, sponsored by 39 representatives, which directed the Board of Health, Department of Fish and Game, Soil Conservation Service, and Beartooth Resource Conservation District to study pollution and current water practices on the Clark Fork of the Yellowstone; HJR 23 urged federal and state agencies to find a substitute for phosphate detergents, HJR 41 urged federal, state, and private organizations to cooperate in the implementation of the Montana Rangeland Resource Program.

The legislature gave substance to its environmental concern by enacting many statutes that are significant additions to the growing body of environmental law in Montana. These could include various enactments that have an indirect impact on the environment: matters of revenue and finance, executive reorganization, and numerous others have consequences for environmental quality. Unfortunately, the scope of this report cannot begin to cover all the legislation in that category. This review will be primarily concerned with the most important and direct environmental statutes, which can be grouped as follows: water and waterway protection, wildlife management, mining and mine reclamation, pesticides and pest control, and general prevention of environmentally abusive practices. Some of the statutes less directly related to the environment will be discussed to point out the impact of such measures on environmental quality.

Water and Waterway Protection

Montana's water received good initial protection in a number of enactments. The Stream Preservation Act of 1967, which announces a policy of protecting and preserving fish and wildlife resources in their natural or existing state except where the need for alteration is clearly demonstrated, was amended by SB 45. As amended, the act requires the Fish and Game Commission to formally document and protest any federal action that violates the Stream Preservation Act. The department has had memoranda of understanding with all federal agencies except the Corps of Engineers. The 1971 amendments supplement the other provisions of the act, which require all state agencies to notify fish and game of any project that alters an existing stream. The department then reviews the projects and aids in planning the mitigation of habitat loss. A refusal by the applicant to modify his plans can lead to arbitration.

Another measure, HB 438, amended the powers of the Fish and Game Commission to permit regulations governing recreational uses of all rivers, streams, and public lakes and reservoirs. These regulations can specifically cover the use of motor-driven boats on all public bodies of water, and therefore constitute a potentially broad grant of authority. Draft regulations, which would close some stretches of river entirely and restict the use of others, were presented at two August meetings of the Fish and Game Commission.

House Bill 22 was enacted to prohibit the placing of junked car bodies in streams. This initial step in recognition of the mounting problem of disposal of unwanted automobiles provides misdemeanor penalties for anyone who places a car body in a stream or river. A deficiency in the act is its failure to set up a program for the removal of car bodies already in streams, nor does it apply to car bodies that dot the landscape and are accumulating in Montana at a rate of some 25,000 per year (2). Since application of the act is limited to persons caught placing autos in streams after the effective date of the measure, Montana still has no comprehensive law dealing with the problem of unwanted cars.

Major revision of state water pollution law was accomplished by HB 85. The authority for implementing the Water Pollution Control Act was transferred from the Water Pollution Control Council (private citizens appointed by the governor) to the Board of Health and Environmental Sciences. One of the enactment's most important features is the board's authority to maintain the existing quality of water unless

> **. . . it has been affirmatively demonstrated to the board that a change is justified as a result of necessary economic or social development and will not preclude present and anticipated use of such waters.**

In addition, the act stipulates that new industries must use the best technology to maintain existing water quality and than in no case can the board reduce standards below the levels previously established under the 1967 water pollution act.

The act contains other important innovations, including the definition of agricultural silt as a pollutant. A recent *Montana Law Review* article discussed two additional advantages of the measure: by stipulating that all interested parties shall have the opportunity to submit data, views, and arguments at hearings and by expanding judicial review of agency action, it is a clearer statute than the former act and encourages more citizen participation (3). Two shortcomings were also noted: the act's definitions and delegations of authority deal with the discharge of substances into water, not with initial appropriation of water; and this act, like most legislation, can be rendered ineffective by inadequate funding.

In regard to the latter, the legislature took a positive step by significantly increasing the budget for water pollution control. Several improvements were made possible under the increased funding: a more active water quality monitoring program, better review of proposed and existing treatment facilities and their discharges, and an improved operator training program. In addition, the legislature made a $4 million appropriation for construction of secondary sewage treatment works.

House Bill 265, the Floodway Management Act, was passed in recognition of the fact that the periodic overflow of watercourses must be considered in land use planning and development. The measure is designed to coordinate federal, state, and local efforts in managing floodway areas. To this end, the act provides technical aid from the state to the counties and empowers the Department of Natural Resources and Conservation to carry out a comprehensive floodway management program. A critical phase of this act is the identification of floodway areas; the department and the Corps of Engineers are currently conducting studies in several parts of the state. However, these studies are very time-consuming, and development activities are not abridged during the study period. Also, when the studies are completed, existing developments are not affected. To mitigate this problem, the natural resources department is encouraging local governments to use existing planning and zoning powers and adopt regulations based on available flood data rather than await the formal completion of delineation studies. Several Montana communities have indicated interest in this procedure. Adoption of such regulations could make communities eligible for flood insurance from the federal Department of Housing and Urban Development. Once eligible, communities can also receive HUD assistance for further detailed floodway studies.

An additional difficulty that may hamper adoption of a state floodway management program concerns compatibility with programs of federal agencies and most other states. Montana's program is based on a 50-year flood standard, whereas the others use the 100-year standard.

Statutes on dam and dike safety were amended by SB 282, whereby the Department of Natural Resources and Conservation is permitted to investigate the safety of a dam or dike without waiting for complaints to be filed. Two shortcomings of the legislation are that small impoundments (up to 100 acre-feet) are exempted from inspections and inspections during construction are not expressly permitted.

Despite the inadequacies noted, the waters of Montana — a primary element of the life-supporting capacity of the environment — are beginning to receive the legislative consideration without which their integrity might be short lived.

Wildlife Management

Montana's wildlife resource also received attention from the legislature. Enactment of SB 144 empowered the Fish and Game Commission to protect raptors and regulate falconry. The act prohibits killing, selling, or transporting raptors, or destroying the nest or eggs of hawks, eagles, owls, herons, blackbirds, and kingfishers. The commission has adopted and implemented falconry regulations under which an applicant for a license must familiarize himself with the practice, construct proper facilities, assemble certain handling equipment, and assure a food supply before he is issued a permit to capture birds of prey.

Three measures concerning the mountain lion were enacted, all dealing with the statutory authority of the Fish and Game Commission. Senate Bill 22 gives the commission regulatory power by designating the mountain lion a game animal, SB 247 gives it the power to regulate hunting the mountain lion with dogs, SB 178 lists stock-killing mountain lions as an exception to an existing statute that prohibits the chasing of any game with dogs. Regulations under these three statutes involve permit requirements, seasons, limits, manner of taking, and reporting.

In general the regulations appear fairly comprehensive. However, one legal complexity presents a problem: the regulations permit the use of dogs in hunting lions, citing the above-mentioned statute that gives the commission the authority to regulate the practice. But by another statute the use of dogs in hunting is prohibited with only two exceptions — stock-killing bears and, by SB 178 amendment, stock-killing mountain lions. The plain wording of SB 178 stipulates that dogs cannot be used to hunt mountain lions in general but only in those cases in which the lion is actually killing stock. The conflict here is readily apparent and should be rectified. The legislature could resolve the problem, but until it does the Fish and Game Commission is apparently bound by both statutes, one of which, in a manner not uncommon in law, limits the other.

By enactment of HB 347, a parcel of land adjoining the Gates of the Mountains Wilderness is set aside as a game preserve. The area is closed to hunting and contains habitat for a number of species. The Fish and Game Commission will administer the act, map and post boundaries, and patrol the area.

Hunting of grizzly bear is perhaps more restricted with the adoption of SB 287. The measure stipulates a seven-year waiting period for any licensed person who has killed a grizzly. The apparent intention of the enactment was to reduce hunting pressure on the bear, which is classified by state statute as a rare species. The Department of Fish and Game is aware that the bear is a wilderness species but does not consider hunting a threat to its existence. The agency admittedly has no precise way of counting the grizzly population but believes that the critical factor in the declining number of grizzlies is reduced habitat.

The 20-year average for annual kills of the grizzly is 37 (6). This does not include the number of grizzlies killed by ranchers on the assertion that the bears are killing livestock. The department at present has no regulations for checking a claim that a bear (or a lion, for that matter) was in fact killing stock and was destroyed for that reason. Judging from the data offered by Dr. John C. Craighead at a recent commission meeting, coupled with inadequate population figures and general lack of information on the bear, it is not clear that the grizzly, once roaming the plains in large numbers, should still be hunted. What appears necessary is a thorough study of the grizzly situation.

The white sturgeon (*Acipenser*) was classified as a game animal by SB 230, thus giving the Fish and Game Commission regulatory power. Little information is available on this fish, since habitat and numbers are extremely limited in the state. Another genus of sturgeon, which includes the pallid and the shovelnose, was not covered by the act. Commercial fishing for any type of sturgeon is not now permitted.

House Bill 555 empowered the Fish and Game Commission to regulate caged fishing operations, which are currently prohibited except by specific permit. The practice is apparently not a widespread problem, although the agency states that it may have some jurisdictional disputes on the Flathead Indian Reservation.

Several enforcement measures were also passed and are being implemented by the commission. Senate Bill 65 permits the agency to enforce environmental quality standards for outfitters and guides. Although this measure was not effective until May of 1972, minimum regulations were adopted requiring operating permits and compliance with whatever environmental protection standards are established for various lands. Apparently no significant problems have arisen, but the enactment does establish and clarify the authority responsible for regulating any potential abuse. The task remaining is to establish necessary environmental regulations for various land uses.

Senate Bill 54 regulates the operation of snowmobiles and provides for certificates of ownership and records of theft. The measure reflects awareness of the serious environmental impacts of off-road motor vehicles. It specifically prohibits harassing any game or fur-bearing animals and also provides that all snowmobiles must be equipped with noise suppression devices and cannot be operated after June 30, 1972 unless the noise level is below 85 decibels at 15 feet. The latter regulation has generated some reaction: national standards are set at 85 decibels at 50 feet, manufacturers say they can meet this standard but not the stricter state standard. The fish and game department is scheduling an implementation education program with snowmobile users this fall. Organized user-groups will be contacted and the noise standards and testing methods will be explained. If these contacts show valid reason, the agency may propose to amend the decibel level to a figure more satisfactory to manufacturers and users. Before any proposal, input should be sought from the Department of Health and Environmental Sciences, which is initiating a noise pollution control program. As the law reads now, any snowmobile sold that does not meet the state standard must bear a conspicuous sign stating that it is not properly equipped. It might be better to prohibit the sale of such a vehicle than permit its sale and place the burden on enforcement officials, who must see the vehicle operating and detect its "conspicuous" sign before taking action.

A change was made in an existing law which provided that persons hunting game animals with wanton disregard for life or property lose hunting-license privileges for 20 years. By HB 412 the term "wildlife" was substituted for "game animal," making the act more inclusive.

The legislative attention to wildlife is a response to increasing public concern about the effects of man on the populations and habitats of wild animals in the state. Implementation efforts appear to share this concern.

Mining and Mine Reclamation

Some of the most important environmental statutory work was done in this area. House Bill 316, the Landowner Notification Act, requires a person contemplating surface disturbance by any mechanical means to first notify the owner in writing of the intent and scope of the proposed operation and receive written approval. If the land is owned by the federal government or by the state or its subdivisions, the person must obtain any necessary permits as well as written approval. These requirements have several exceptions notification provisions do not apply if the operation is within the terms of an existing prospecting permit or lease or other agreement authorizing the operation, or if the operator owns 100 percent of the mineral rights on the land in question. The act does not specify the agency charged with its supervision or administration. However, it has evidently proved valuable to the Forest Service and the Bureau of Land Management in their effort to regulate conflicts between surface and mineral rights.

Two major enactments deal with mine reclamation. The first is SB 70, the Open Cut or Strip Mined Land Reclamation Act. It applies to bentonite, clay, coal, sand, gravel, phosphate rock, and uranium. Under its provisions any mine operator planning to remove 10,000 cubic yards or more of material must enter into a reclamation contract with the Board of Land Commissioners before commencing the operation. All reclamation to be performed is bonded. Recommendations of a seven-member advisory committee created by the act, local conditions, and potential uses of the land are weighed in determining the specific reclamation procedures. Under contract provisions, the land is to be reclaimed in the most effective way to preserve natural resources, protect wildlife and aquatic resources, safeguard future development sites, and protect health, safety, and general welfare. Part of the reclamation cost is borne by the public treasury. half the cost of the activity or one cent per ton, whichever is the smaller figure, is rebated to the operator quarterly.

The second measure is HB 243, the Hard Rock Mining Reclamation Act, which applies to essentially all minerals not covered by the strip mine act. Persons engaging in exploration, development, or mining must obtain a permit from the state land department if their proposed operation will remove at least 100 tons in the aggregate in any 24-hour period. "Small miners" who are thus excluded from the act are required to affirm that they will not pollute or contaminate any stream, that they will provide necessary protections for human life and safety, and that the total amount of land disturbed and unreclaimed will not exceed five acres. All larger operations are subject to regulations based on the following considerations. potential uses of the land, grading and revegetation, procedures to control drainage and prevent stream pollution protection of human life, property, wildlife, and vegetation, and a time schedule for reclamation operations. The thrust of these considerations is to allow for exploration and mining of valuable minerals while providing for the subsequent beneficial use of the reclaimed lands.

Progress under these two enactments is explored further in Chapter IV.

Senate Bill 7, Extraordinary Session I, modifies the state requirements for staking and maintaining a mineral claim on federal lands. These amendments may lead to beneficial as well as adverse environmental impacts. Deletion of the requirement that a 150-cubic-foot pit be sunk before a mineral discovery can be perfected will prevent needless environmental disturbance and save operators time and money. A provision that may have adverse environmental consequences requires annual assessment work. Prior to the enactment of this measure, an operator could apply assessment work done on one claim to all contiguous claims. Small miners protested that this made it too easy for large operators to tie up tracts of land without developing their mineral potential. Accordingly, the current provision limits application of assessment work done on one claim to only 10 contiguous claims. The problem with such a limitation is that instead of helping the small miner gain access to developable land it may cause unnecessary assessment work on land contiguous to a major operation merely to satisfy state requirements. It is doubtful that large holders of mineral claims will permit them to lapse and be taken over by small operators. Since the effect sought may not at all be the one obtained, this measure deserves further consideration.

Pesticides and Pest Control

After three unsuccessful attempts in previous legislatures, a broad act for control of pesticides was passed. Senate Bill 126 vests primary authority for administering the act with the Montana Department of Agriculture. It provides for annual registration of pesticides, licensing of applicators and dealers, the form of distributed products, regulation and prohibition of the use of pesticides, administrative procedures, and judicial review of agency decisions. The department has begun to implement this program, but a shortage of funds and laboratory facilities may keep it from being as comprehensive as desirable.

Senate Bill 258 creates a temporary position in the Department of Health and Environmental Sciences to conduct a pilot project in mosquito control in the Milk River Valley and to recommend a comprehensive mosquito abatement program for the state. The interdepartmental advisory council created by the act has sent guidelines to the Environmental Quality Council and the Department of Highways for use in various projects that may contribute to growth of mosquito populations.

Prevention of Environmental Abuse — General

A number of measures deserve mention primarily because they are efforts to prevent land abuse, a form of environmental degradation increasingly at issue. Two statutes deal with the problem of littering. Most comprehensive of these is HB 112. Under the act, anyone who litters, except on his own land, is guilty of a misdemeanor and is punishable by a fine of $10 to $500, imprisonment, or both, or, alternatively, by a judge-directed cleanup of the littered area. The cleanup provision has been used in only one case in the last year; fining or sentencing has been used in nearly 50 other cases brought under the act.

The second anti-litter act is SB 138, under which a person convicted of littering while hunting forfeits his license and camping privileges within the state for 90 days. Copies of both of these enactments have been furnished to fish and game law enforcement personnel. Both represent some progress in the face of a growing and seemingly unmanageable problem.

Two measures were enacted affecting land use and development powers of local governments. Although that body of law remains scattered and confusing, the measures are encouraging. Park dedication provisions — formerly requiring the dedication of one-ninth of any city or town development over 20 acres for public parks and playgrounds — were amended by SB 63. The act removes the 20-acre minimum for invoking the requirement and permits flexibility in dedications made by small-unit developments. In lieu of dedicating one-ninth of a development for parks and playgrounds, the fair market value of land needed to meet the park requirement can be paid to the park fund. This alternative can be exercised only if some good cause is shown, upon such showing the amount of money is deposited in the fund to assure open spaces in the future. More important, the amended provision stipulates that local authorities must approve any city or town subdivision and in doing so must consider public comfort, welfare, and safety. Through adoption of subdivision regulations, county commissioners, or the governing body of a city or town, are required to provide for harmonious development, open spaces, transportation, water conservation, sanitation, and avoidance of population congestion. This imposes a substantial affirmative duty on local governments, but implementation has been slow.

Significant legislation establishing countywide planning and zoning powers was enacted in HB 79. This measure should have a healthy impact on land use regulations and patterns. It gives county commissioners the authority to set up advisory planning boards and after doing so to zone countywide. Commissioners can require that all subdivisions conform to an adopted master plan; in formulating and applying the plan they are required to seek the advice of the planning board.

The act also provides emergency interim zoning authority in cases where environmental quality or public health, safety, or welfare will be adversely affected. Two counties — Lewis and Clark and Missoula — are considering use of this authority; doing so requires interim adoption of a master plan and implementation of zoning restrictions. Another important feature of the enactment is the explicit authority for cities that currently have master plans to extend their zoning and subdivision powers beyond their corporate boundaries to critical fringe areas. To date, no city has used these extraterritorial powers, but they will no doubt become more acceptable as uncontrolled development continues to affect the governability of cities and the quality of the environment.

Although the Department of Planning and Economic Development does not have explicit authority under HB 79, it assists local units in planning and implementation and administers available federal funds.

Three other enactments broaden the authority of local government units. All should have beneficial environmental consequences. Under HB 501, cities and counties can create special improvement districts to convert overhead electrical and communications facilities to underground locations. An alternative to public funding of conversion is seen in a recent New York Public Service Commission recommendation that each electric and telephone company be required to earmark two percent of gross revenues for projects to place overhead lines underground (5). The esthetic potential of this kind of activity is obvious.

House Bill 96 gives counties the authority (in addition to their preexisting authority to contract indebtedness) to issue special or rural improvement district bonds for financing flood control and water conservation projects. House Bill 135 amends the Refuse Disposal Act of 1969 to permit cities and counties to create defined districts for refuse disposal. Twelve districts have been formed, involving Cascade, Deer Lodge, Flathead, Gallatin, Glacier, Lake, Lewis and Clark, Lincoln, Mineral, Park, Ravalli, and Sanders Counties.

Enabling legislation such as HB 79 and the three enactments described above is, of course, essentially permissive and does not promise, let along require, significant action. Recent defeat by Gallatin County voters of the county commissioners' resolution to establish a county planning board is a sign that such legislation can be overturned. It can also, as is the case with nearly all legislation, be ignored. This being true, one of the most important environmental activities in the future will be to monitor and assess the action or inaction of local governments.

A bill to regulate outdoor advertising along interstate and federally aided primary systems was passed in the face of a federal threat to delete 10 percent of the federal funds received by the state highway department. During the 1971 second extraordinary session, the legislature was reminded that a measure passed during the regular session — HB 169 — did not meet minimum requirement of the federal Highway Beautification Act of 1965. Accordingly, SB 1, Extraordinary Session II, was enacted to correct the deficiency. Although the federal act specifically permits states to go beyond the federal minimum, this was not provided by the legislature, nor is it contemplated by the highway department.

Under the state act, regulation of outdoor advertising is justified in order to promote safety, convenience, and enjoyment of highway travel, to protect public investment in state highways, and ". . . to preserve and enhance the natural scenic beauty of esthetic features of the highways and adjacent areas . . ." The act specifies that signs are permitted in unzoned commercial and industrial areas only on agreement between the Montana Highway Commission and the Secretary of Transportation, signs in zoned commercial and industrial areas are not prohibited. Directional or official markers or signs that advertise sale or activities on property on which they stand are also not prohibited. The act includes specifications for size, construction, and lighting for permitted signs. All other signs within 660 feet of the right-of-way and visible from the main road are prohibited.

The long-drawn-out compliance with the federal Highway Beautification Act bore fruit in late April of this year when the Montana Highway Commission adopted regulations pursuant to SB 1. These regulations, which mostly restate provisions of the act, should speed the receipt of federal funds, a crucial point, since SB 1 specifies that no signs, except unlawful outdoor advertising, can be removed until such funds are available.

An early application of the act was to a series of signs being erected between Gardiner and Livingston in May, an activity that led to complaints by various citizens and legislators in the area. Some of the signs are apparently illegal advertising under the act, but the highway department is investigating at a speed too deliberate for at least two legislators. A recent resurgence of vigilante operations in the state is an indicator of citizen impatience with the slow implementation of the measure.

Miscellaneous Environment-Related Statutes

This section discusses several measures whose implications are not usually thought to be environmental. Hopefully it will indicate the importance of identifying environmental impacts that may result from such statutes.

Passage of SB 203 showed concern with the pollution-free condition of the working environment. The Occupational Health Act is designed to protect the health, safety, comfort, productivity, and well-being of workers through a statewide program of occupational disease abatement. Regulations, promulgated and adopted after hearing by the Board of Health and Environmental Sciences, establish restrictions on exposure to air contaminants, noise, and laser energy. Powers of the board include the authority to conduct research and to develop comprehensive occupational health plans. Research to date includes: an occupational environment study at the Anaconda Company aluminum plant near Columbia Falls covering air quality and noise levels, studies of mercury vapor and concentration in dental offices and laboratories, noise-level studies in auto repair, construction, maintenance, and welding shops, inspections for mine safety, and other studies in dry-cleaning establishments, plastic plants, etc. In some cases, the health department has made recommendations for alleviation of problems.

To say that activity in the revenue field may have an impact on environmental quality is to take notice of a commonplace. Two taxes dealt with by the 1971 legislature involve operations that have direct environmental implications. Passage of the electrical energy producers tax was made permanent at a rate of 1.438 percent of gross production market value. This rate was assigned in the 1969 session and apparently was decided to three decimal places on considerations of needed revenue only, that is, the amount of revenue needed to balance the budget was used to compute the tax rate. At present this is the state's only direct energy tax and has little if any effect on environmental impacts of electrical energy operations.

The same is true of the coal strip mine tax, which was amended by HB 581. Prior to the enactment, coal was taxed at five cents per ton after 50,000 tons. The rate structure now varies with BTU rating: from five cents per ton of coal rated 6,000 BTUs or less to 10 cents per ton above 9,000 BTUs. The first 5,000 tons are exempted by a curious provision that seems to have no justification. The intent of the previous 50,000-ton exemption was to avoid saddling small operators with costs of administering such a tax. However, since there apparently are no operations in the state which would be affected by the current 5,000-ton exemption, the original intent seems no longer to apply.

At first glance, HB 581 is in effect a fairly straightforward increase in the strip mine tax. But under the 1971 Strip Mined Land Reclamation Act, up to half the cost of reclamation is credited to a producer's liability under the strip mine tax. As noted previously, the credit cannot exceed one cent per ton of coal. Through this procedure the public treasury provides an incentive for reclamation.

An increase in the strip mine or the electrical energy producers tax can have, as a rough rule of thumb, a dampening effect on total production, reducing the tax, or enacting one that does not significantly affect producers' policy decisions, can encourage production, subject of course to other market and nonmarket considerations. In either case, since both strip mining and energy production have a substantial and immediate environmental impact, adjustments of tax rate structures should be given environmental and economic analysis. This would be even more necessary if taxes were used as environmental regulatory devices in addition to or instead of their sole current use, revenue raising.

Senate Bill 281 is an example of legislation that may have been passed without sufficient consideration of its potential environmental impact. It provides for the exchange of state coal leases issued before July, 1967. Prior to that date leases were generally issued for 10-year periods. A 1967 amendment permitted future leases to be issued for 20-year periods. The 1971 amendment permits leases issued before July 1, 1967 to be exchanged for leases on the same lands for a term of 20 years from the original lease date. This change admittedly does not yield an immediate environmental impact, however, the 1971 amendment accomplished a 10-year extension of the lifetime of leases which otherwise would have expired between 1971 and 1977.

The Comptroller General of the United States, in a recent report to the Department of Interior titled *Improvements Needed in the Administration of Federal Coal-Leasing Programs*, counselled against this kind of extension, stressing that a 20-year period for federal leases is too long without review. The report contained a recommendation that the Secretary of Interior study the desirability of changing the law to permit adjustment of royalty rates and other lease terms, such as restoration of lands, more frequently than at 20-year intervals (4). Perhaps this should also be the case in Montana, since an extension of the time period before which a lease is reviewable could preclude, or at least obstruct, the timely incorporation of environmental considerations. This is especially crucial in regard to coal development, where certain environmental effects will probably be discerned only as development proceeds. In the case of leases negotiated in the early 1960's, it is clear that many such impacts were not fully assessed. Concern about the potential environmental abuses of coal mining might have caused SB 281 and its 1967 counterpart to receive further consideration before passage. All such bills require more scrutiny and assessment of potential impacts as a prerequisite to enactment if a consistent body of environmental law is to develop.

Conclusion

No discussion of new environmental law would be complete without mention of HB 66. The Montana Environmental Policy Act established the Environmental Quality Council (EQC). The act specifies a citizen's right to a healthful environment and a responsibility to preserve and enhance that environment. State agencies are required to take certain steps to insure that environmental quality considerations are given a high priority in decision-making. The EQC is given a list of duties to perform in overseeing and publicizing activities of these agencies. To be certain that all relevant information for the performance of this function is available, the council is given access to agency records, books, and files. Further discussion of the implementation of the act is in Chapter IV.

This review indicates the environmental concern that surfaced in the 1971 legislature. Although some very important measures were defeated, including measures on citizen access to the judicial process, it is clear that legislative and administrative efforts are being made to restore and maintain an environment of high quality and that the state is assuming its role as trustee of the environment for succeeding generations.

Upcoming legislatures will need to give more attention to adequate funding for environmental quality programs. As noted above, some significant funding was provided for water pollution control and sewage treatment in the Department of Health and Environmental Sciences. Other agencies will undoubtedly require similar consideration if they are to translate legislative intent into effective practice.

It is possible to stress the use of statutory tools in maintaining and improving environmental quality to the point where other efforts are overshadowed. Positive legislation and supervision of administrative activity are obviously necessary, but even the most consistent efforts by all branches of government must be stimulated by the continuous action of public-minded citizens. A discussion of these activities follows.

References — Legislation

Legislators who introduced the bills discussed in the text are named below in the order in which they signed the measures. The name appearing first after each bill is that of its chief sponsor. Also listed are title and section numbers of the acts in the *Revised Codes of Montana (RCM 1947)*.

Senate Bills

SB 22 Northey, Klindt, Carl, Lynch, Stephens, Boylan, Deschamps, Turnage, Flynn, and Mitchell. 26-201
SB 45 Mitchell, Northey, Klindt, Turnage, McGowan, Cotton, Bertsche, Gilfeather, and Lowe. 26-1501 et seq.
SB 54 Lynch, Beardon, and Shea. 53-1012 et seq.
SB 63 Drake, Siderius, Klindt, Bosell, McCallum, Bollinger, Hibbard, Northey, and Hazelbaker. 11-602 et seq.
SB 65 Lowe, Northey, Groff, Vainio, Stein, Graham, and Moore. 26-908 et seq.
SB 70 McGowan, Bugg, Mitchell, Moritz, Mathers, Dzivi, Bertsche, McCallum, and Bosell. 50-1018 et seq.
SB 126 Graham, Sorensen, Mitchell, and Hazelbaker. 27-213 et seq.
SB 138 Klindt, Lowe, Flynn, and Shea. 26-812 et seq.
SB 144 Northey, Klindt, Hazelbaker, Mitchell, and Bertsche. 26-501 et seq.
SB 178 McCallum, Bugg, Moore, Bostad, Bosell, Sorensen, McGowan, and McOmber. 26-301.5 et seq.
SB 203 Sheehy, Beardon, Flynn, and Goodheart. 69-4206 et seq.
SB 230 Hafferman. 26-201 et seq.
SB 247 Northey, McCallum, and Deschamps. 26-303.5 et seq.
SB 258 Goodheart, Bollinger, Stephens, and Sheehy. Temporary enactment, not codified. See Chapter 186, Session Laws of 1971.
SB 281 Sheehy, Mackay, Brownfield, and Graham. 81-502 et seq.
SB 282 Lynch, James, McOmber, and McDonald. 89-702, 89-702.1 et seq.
SB 287 Klindt, Drake, Lowe, and McOmber. 26-202.2 et seq.
Extraordinary Session I, SB 7. Natural Resources Committee. 50-704 et seq.
Extraordinary Session II, SB 1. Beardon, Broeder, Stein, Manning, Northey, McGowan, Moritz, and Graham. 32-4701 et seq.

House Bills

HB 22 Yardley and Warfield. 94-3552.1, 94-3552.2 et seq.
HB 66 Darrow, Lucas, Lundgren, Mather, Christiansen, Fasbender, Cox, Harrison, Schoonover, Fagg, Nichols, Ainsworth, Jackson, Johnston, Bradley, Scott, Ulmer, Heinstad, C. Smith, and Keller. 69-6501 et seq.

HB 79 Robbins, Fagg, Cox, Nichols, Bradley, Parrish, and Hall 11-2702, 11-3801, 11-3810 through 11-3815, 11-3825, 11-3830.2, 11-3842 through 11-3844, 11-3846 through 11-3848, 11-3851, 16-4101, 16-4702, 16-4703, 16-4705, 16-4711 et seq

HB 85 Ainsworth, Darrow, Bradley, Schoonover, Swan, Bardanouve, Marbut, Norman, Keller, Bennett, Watt, Christiansen, Ulmer, Baeth, Lucas, Olson, Haines, Campbell, Worden, Lundgren, Kendall, T. L. Murphy, Fitzgerald, Towe, Brown, Parrish, Johnston, C. Smith, Nichols, Scott, Forester, Prevost, Eggebrecht, Sversten, Lanthorn, Lockwood, Zimmer, and Anderson 69-4801 et seq

HB 96 Ulmer, Parrish, Robbins, and Asbjornson 89-3301 et seq

HB 112 Bradley, Parrish, Cox, Fagg, Jackson, and Ainsworth 94-3335 et seq

HB 135 Kendall, Gunderson, Campbell, and Ainsworth 69-6012 et seq

HB 243 Fagg, Bradley, E. Smith, T. Murphy, Prevost, Norman, Ulmer, Robbins, Snortland, Glennen, Darrow, Schoonover, Towe, Fasbender, Hall, Forester, Cox, Scott, Warfield, Lund, Yardley, Johnston, McKittrick, Weeding, Zody, Gunderson, and Shelden 50-1201 et seq

HB 265 Darrow, Jackson, Weeding, Bardanouve, Campbell, Cox, Robbins, Keller, Anderson, Warfield, and Asbjornson 89-3501 et seq

HB 316 Darrow, Warfield, Ainsworth, Bardanouve, Johnston, Anderson, Haines, Falkenstern, Dye, and Jackson 50-1301 et seq

HB 347 Patrick, Bennett, Ainsworth, Nelstead, Worden, Lanthorn, Towe, and Lundgren 26-1128 et seq

HB 412 Nichols and Fitzgerald 94-35-269 et seq

HB 438 Swanberg, Parrish, Fagg, Schoonover, Nelstead, and Yardley 26-101 et seq

HB 501 Fagg 70-601 et seq

HB 555 E. Smith and Barnett 26-801, 26-814 et seq

HB 581 Christiansen, Ulmer, Norman, Weeding, Zody, and [illegible] 84-1302 through 84-1304 et seq

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2. Carmody, T. D. 1970. Addendum to Montana solid waste status report and management plan. Department of Health and Environmental Sciences, Helena.
3. Clark, M. and P. B. Harper. 1971. Water — a problem in Montana. *Montana Law Review*. 32(1):91. Condensed version in *Montana Business Quarterly* 9(3):45.
4. Comptroller General of the United States. 1972. Improvements needed in administration of federal coal-leasing programs. U. S. Government Printing Office, Washington, D. C.
5. *Montana Rural Electric News*. 1972. April.
6. Mussehl, T. W. and F. W. Howell (eds.). 1971. Game management in Montana. Department of Fish and Game, Helena.

Citizen Efforts

Citizen activities are an essential part of the pursuit of a high-quality environment. In Montana, increased public interest in decisions affecting environmental quality can be seen in recent hearings on state air quality standards and on the proposed construction of a publicly funded spur road to the Big Sky Corporation development. The League of Women Voters and others sponsored seminars on the types and levels of state standards to inform and induce public discussion on an Anaconda Company-American Smelting and Refining Company petition requesting the repeal of the state sulfur-oxide emission standard and the reduction of ambient standards to federal levels. Subsequent hearings held by the Board of Health and Environmental Sciences were well attended, and citizen testimony was invaluable to the board in its decision to affirm the higher state standards.

The public hearing held on the Big Sky spur road was also well attended and variously described as "healthy" to "sometimes raucous" and "unruly." Private citizens, representatives of various organizations, and state agencies offered comments on the need for such a road and on the various routing alternatives proposed by the Department of Highways. Citizen action continues as of this writing with a suit filed against the federal Secretary of Transportation contending that public funds should not be expended on the project.

Another series of hearings at which the public had considerable voice concerned a bill, introduced by Senator Lee Metcalf, which would establish the Missouri Breaks Scenic Recreation River, thereby preventing the river's last free-flowing stretch between Fort Benton and Robinson Bridge from becoming a reservoir.

These are among the signs that the public hearing — a place where a vigorous citizenry can help formulate and review government decisions and alternatives — will be a fixed feature in the discussion of environmental matters.

Of particular interest to citizens in the future will be new constitutional provisions as well as existing statutes concerning citizen participation in governmental procedures. Two provisions of the new constitution stipulate guaranteed rights: The first states that

> No person shall be deprived of the right to examine documents or to observe the deliberations of all public bodies or agencies of state government and its subdivisions, except in cases in which the demand of individual privacy clearly exceeds the merits of public disclosure (Article II, Section 9).

The second, more of a constitutional sermon, announces that

> The public has the right to expect governmental agencies to afford such reasonable opportunity for citizen participation in the operation of the agencies prior to the final decision as may be provided by law (Article II, Section 8).

The document also stipulates that all sessions of the legislature, including committee of the whole, committee meetings, and hearings shall be open to the public (Article V, Section 10 (3)) and that

> Every vote of each member of the legislature on each substantive question in the legislature, in any committee, or in committee of the whole shall be recorded and made public. On final passage, the vote shall be taken by ayes and noes and the names entered on the journal (Article V, Section 11 (2)).

All the above provisions are valuable in the notice they serve on the legislature and executive agencies that public affairs must be conducted in public. In addition, they provide room for the judicial branch to develop grounded case law on citizen access and participation. Public-minded citizens will want to be sure that legislative action on these provisions fulfills their potential.

Several Montana statutes incorporate specific public hearing procedures. The Administrative Procedures Act provides for them after reasonable notice in contested cases. Other statutes — for example the Clean Air and Water Pollution Control Acts — require public hearings prior to promulgating, amending, or repealing regulations. Analysis of these statutes, and any applicable administrative regulations, will not only inform prospective participants but should lead to suggestions for improvement. As increased citizen participation proceeds, the statutes defining its exercise will almost certainly need change in their substantive and procedural aspects.

The following list of citizen groups and their environmental activities is not comprehensive; Environmental Quality Council files on these groups are incomplete and difficult to keep current. Any omissions are regretted, and perhaps a more thorough overview can be accomplished at a later date. The point of the present exploration is to indicate the potential for citizen involvement as reflected in the activities of groups that provided information for this review.

The Montana Wildlife Federation (MWF), an affiliate of the National Wildlife Federation, is the oldest and largest environmental group in the state. Founded in 1936, the group has 51 affiliate chapters and somewhere in the neighborhood of 10,000 members. Each affiliate is represented in votes on policy matters. A board of directors meets four times a year in addition to the annual convention where resolutions on important environmental questions are passed. This year's convention was sponsored by the Gallatin Sportsmen, an affiliate chosen as one of the 16 outstanding chapters of the National Wildlife Federation.

MWF puts out an eight-page monthly newspaper, *Montana Environmentalist*, which covers the main environmental issues in the state. The group is represented at nearly every hearing on environmental matters and maintains a full-time lobbyist during legislative sessions. Bulletins on the progress of environmental legislation keep members informed and enable them to appear and support various measures. MWF was instrumental in the passage of the 1965 Stream Preservation Act and has taken a position urging that the enactment be made applicable to private parties as well as state agencies — a position supported by the Environmental Quality Council (see recommendations, Chapter V).

The continually revised MWF statements of policy show a commitment to issues beyond fish and wildlife. The statements on land and water policy, supplemented by resolutions, are notable in this respect, urging consideration of the intrinsic values of natural amenities. Recent resolutions support the Scotchman Peak wilderness designation, the executive order on predator control, more funds for silviculture, and a reduction of nonessential energy consumption. Perhaps more than any other group, MWF performs the necessary coordinating function for the diverse environmental groups of the state.

The League of Women Voters is a broad interest group that works on a number of political issues at the national, state, and local levels. In the environmental area the league, apart from its previously mentioned seminar on state air quality standards, recently held a seminar on land and water use. The latter was an action-oriented discussion of land use problems and potential controls.

The American Association of University Women is also becoming increasingly active in environmental matters. The group supported the abortion bill of the 1971 legislative session and works for increased family planning services. Future activities will concentrate on environment-related public hearings, stronger reclamation laws, and recycling and solid waste problems.

The Montana Conservation Council is a 23-year-old group that has maintained a nonpartisan stance to enable it to serve as an environmental forum. It has a lobbyist in Helena during the legislative sessions, was a catalyst for early legislation concerning environmental education and conservancy districts, and has drafted a book on conservation education that is distributed by the office of the Superintendent of Public Instruction. The council hopes to continue as essentially a neutral ground for discussion of resource problems.

The Environmental Communications Council is a recently incorporated education group centered in Billings. Its main activity, at public meetings, on "show-me" tours, and through its publication, *Ecolog*, is to generate crosscurrents of information between groups with divergent attitudes on environmental matters. The council appears to have a good chance for continuity with a diverse membership that includes the Montana Power Company, Humble Oil, Kiwanis, Forest Service, American Association of University Women, and Bull Mountain Landowners Association. Public meetings on air quality standards and energy resources have been well attended. By avoiding an advocate role, the council, like the Montana Conservation Council, hopes to serve primarily as an avenue for dialogue.

The Montana Wilderness Association (MWA) is an active group that in recent years has expanded its emphasis from promotion of wilderness to a wide spectrum of environmental issues. MWA representatives have testified at nearly every legislative or agency hearing on air and water quality, land use planning, mining reclamation, wildlife conservation, etc., in addition to wilderness matters. A special project of the group has been the now completed process of wilderness designation for the Lincoln Back Country and Scapegoat Mountain area. In achieving this goal, the group recently opposed a Forest Service effort to delete 12,000 acres near Benchmark from the wilderness boundaries. It argued at a public hearing in Great Falls that the root of the problem would be ignored if boundaries were pushed back in the face of recreational pressure instead of reducing the pressure itself. About half of the acreage was reinstated. The MWA has vigorously supported candidate study areas in national forests. It strongly endorsed the general thrust of the Yellowstone Master Plan, which designates sizeable sections of the park as wilderness, but opposed the concept of enclaves and buffer strips whereby qualified wilderness land would be left outside the designations. Public action by MWA members has included personal contact with members of Congress, news releases, radio interviews, and lectures on many environmental issues. Testimony was offered in support of a public trust provision in the new state constitution.

An important special activity of the MWA is the wilderness walks program conducted each summer. The program includes one- to seven-day hikes into the Montana backcountry, float trips on the Missouri River, and other excursions. The wilderness walks are without charge, are led by MWA members, and have attracted hundreds of people from throughout the nation.

The MWA has also met with the Bull Mountain Landowners Association and Sarpy Creek residents in efforts that led to the formation of the Northern Plains Resource Council. This latter organization is concerned about the critical question of whether Montana coal should be strip mined. It was formed in response to the North Central Power Study — a series of plans for coal and energy development that evidence little or no concern about environmental quality. The council supports Congressman Hechler's bill, cosponsored by 84 members of the House of Representatives, to ban strip mining.

Sierra Club groups in Montana have been active in a number of environmental concerns. Their activities include review of federal and state projects, testimony at hearings, and correspondence with government officials. The Upper Missouri group (Helena) has sponsored meetings on management of the Elkhorn and Big Belt regions of the Helena National Forest. It testified in support of Metcalf's Missouri Breaks legislation, the state sulfur-oxides emission standard, and a moratorium on the hunting of grizzly bear until studies are completed. It has reviewed and commented upon proposed timber sales in the Helena National Forest; wilderness candidate areas in the Bitterroot, Beaverhead, Lewis and Clark, Deer Lodge, and Helena National Forests, wilderness management of the Bob Marshall, and proposed wilderness designations in Yellowstone, Teton, and Glacier National Parks. The group also supported closure of certain motorcycle trails in the Lewis and Clark forest and urged prohibition of motorboats on stretches of the Yellowstone and Missouri Rivers. It has opposed Forest Service land exchanges affecting the Big Sky development, weather modification activities in the Bob Marshall, and the chemical thrust of predator control programs.

Sierra Club groups in Bozeman and Missoula have been similarly active. The latter has put special emphasis on timber matters, notably management of Rock Creek. In general, the daily involvement of Sierra Club members typifies the crucial environmental work that can be done behind the headlines.

Several local organizations are offshoots of the national Audubon Society. One, the Sacajawea group, has supported the federal ban on certain pesticides for predator control, establishment of the Snake River Birds of Prey Area south of Boise, wilderness designation of the Absaroka and Beartooth Primitive Areas, and new state legislation on falconry. The group has conducted an educational program of environmental movies shown to nearly 4,000 school children and, with high school student involvement, has banded 29,000 gulls in the Freezeout Lake area near Great Falls. It also conducts field trips with Montana State University summer students

The Kalispell Rotary and Chamber of Commerce, in two separate projects, have set good examples for community cleanup. Rotary formed a limited-partnership land improvement company and purchased 10-and-a-half acres of land covered with junked vehicles and debris. It cleared, leveled, and seeded the land, and plans to sell the property with restrictive covenants attached to prevent future degradation. Proceeds from the land sales will be invested in new projects and the initial investment will be used as a revolving environmental fund

The Kalispell Chamber of Commerce successfully involved citizens in a sizeable junked-auto cleanup. After a series of public slide shows depicting both the beauty and the junk of the Flathead Valley, the chamber ran a series of newspaper ads complete with a coupon authorization to pick up a junked auto. With volunteer help and equipment, nearly 2,000 cars were collected, a Spokane firm brought a car flattener which put the vehicles in reprocessing shape at the rate of 50 to 75 per day, and the cars were placed on flatbeds and hauled out of state for scrap. An interesting adjunct to the project was that a number of old farm implements, appliances, and metal tanks and containers were also collected. The flattener was used in a number of other towns and apparently is available for future collections of at least 50 junked autos. The Kalispell project now depends on owners assuming the responsibility for transporting car bodies to the city's sanitary landfill, where they are crushed periodically for reprocessing.

Another car body operation is being conducted by Weissman and Sons of Great Falls in conjunction with service groups along the High Line. As reported, several hundred thousand cars have been flattened and sent off for reprocessing during the past few years. The project is encountering some difficulties, such as long-haul freight rates and finding an acceptable way to clean the car bodies of rubber and fabric. Health department regulations do not permit burning the vehicles. An environmental and economical resolution of these problems may be essential if the operation is to continue. This project is indicative of the approaching situation in which scrap metal reprocessing will become a necessary environmental practice

After the Clean Air Act of 1967 had been in effect for about a year, a small group of women in Missoula organized with the intent of prodding its implementation. The group, Gals Against Smog and Pollution (GASP), directed its efforts to alleviating the air quality problem in the Missoula Valley from trash burning, tepee burners, and the Hoerner-Waldorf pulp mill. Pressure was put on all contributors to the local problem to reduce effluents. GASP was responsible for obtaining sufficient signatures for the establishment of a local air pollution control board under the 1967 Clean Air Act. It has supported the state's first and subsequent emission standards. Current activities include testifying at all air quality hearings and monitoring the Hoerner Waldorf pollution control program.

The Montana State Council of Trout Unlimited (TU) is an affiliate of the 15,000 member national group. The state has eight chapters with approximately 650 members. The main goal of TU is to preserve the cold water fisheries of North America. This is an especially important function in Montana, which contains nearly 40 percent of the nation's trout streams. The group, responding to the environmental fact that all pieces of the universe are hooked together, is concerned with more than fish. During the last legislature, TU supported 10 measures, including the prohibition of junked car bodies in streams, the statutory recognition of recreational waterways, and the designation of recreation as a beneficial use of water. Work is also being done on the potentially exorbitant water claims of energy development and the watershed effects of clearcutting. TU also lobbied the constitutional convention for strong environmental provisions.

The National Forest Preservation Group (NFPG) is a recently formed nonprofit corporation that favors the continued public ownership of public lands. The group's special concern is that the public land base and its diversity remain intact. Accordingly, NFPG first opposed and later took court action against two land exchanges between the Gallatin National Forest and Burlington Northern Railroad involving land near the Spanish Peaks Primitive Area. The land received by the railroad will become part of the Big Sky second-home and recreational development. NFPG contends that the exchanges were unfair to the public on two counts: that the lands traded away were more valuable in monetary terms and that the lands received were already open to public use and unsuitable for development. A separate legal action, noted earlier, is challenging the use of public funds in the construction of a primary road into the Big Sky development. In addition, the group advocates return of railroad grant lands to public ownership on the theory that the grants have outlived their purpose and that private ownership hampers effective management of these lands for public benefit.

A well-known national group working for a stable population size has a Bozeman chapter. Zero Population Growth is primarily an educational undertaking to create awareness of the worldwide population problem. This is sometimes difficult in a sparsely populated state where the pressures are not yet directly felt; however, such awareness it viewed as being most needed in areas just such as this because of the high standard of consumption characteristic even of Montana and the higher potential for destruction of remaining environmental amenities. The group, which cooperates with family planning services, has booths at various fairs, distributes literature, schedules speakers, and conducts panels in an attempt to increase the quality of discussion on a sane population policy.

Another group concerned about the pressures of population growth has set up the Gallatin County Family Planning Service. This effort was initiated by concerned citizens and is now headed by an 18-member local board. Funds from the federal Department of Health, Education, and Welfare have been used to employ a director and a family planning expert. Counselling is available to persons of childbearing age on a variety of reproductive health problems. After consultation with a physician, contraceptives can be obtained without cost. The service is funded to handle approximately 250 persons this year, an allotment that may be doubled in response to steadily increasing interest. One of the critical features of the program is the availability of doctors who are willing to participate, either voluntarily or on a fee basis. As the program reaches more people, more involvement from the medical profession will be necessary.

The Montana League of Conservation Voters was formed in early 1971 to monitor and support candidates and public officials considered to be friends of the environment. Since that time, the group completed a voting-record analysis on the members of the 1971 legislature. Bills thought to be key environmental indicators — mine reclamation, citizen suits, etc. — were selected. Legislators were then rated on the environmental soundness of their voting records. The weakness of this kind of analysis is the spotty nature of recorded votes. Future monitoring will be more consistent and may include notes on floor debates and committee deliberations not recorded in the legislative journals. The league circulated an analysis of the special-interest connections of members of the Constitutional Convention Prepartory Commission. It also queried all candidates for the constitutional convention and found a surprising number who believed that the document should contain environmental provisions. Candidates for the convention and for the recent 1972 primary election were endorsed on the basis of their responses. The league lobbied during the convention. More questionnaires are being prepared for the upcoming general election endorsements.

The Bull Mountain Landowners Association, mentioned previously as a founder of the Northern Plains Resource Council, is an example of a local group with the potential of growing into a statewide lobby against strip mining. The group was formed when ranch owners became concerned about strip-mining plans in the Bull Mountains. Convinced that local topography, the location of coal seams, and overburden problems made adequate reclamation impossible, it suggested a moratorium on strip mining in the area. This has been followed by an extensive letter-writing campaign, newspaper coverage, public meetings, seminars, and field trips to view sites that have been or may be affected. The group initiated court action against the reclamation plan for the Steffans test pit, contending that the Consolidation Coal operation did not include the best reclamation available. It hes also joined a number of other environmentally concerned organizations, as noted, and has received assistance from various state and national groups with mutual concerns.

An innovative environmental program is the Falls Creek project near Condon. Initiated to stimulate environmental awareness, self-discovery, and human community, it has grown into a diverse experiment in environmental education. Programs in the last year included environmental education workshops for Kalispell, Salmon Prairie, and Darby public schools; a summer environmental awareness program, fact-finding missions to the Butte mines, Anaconda's Stillwater mine site, the Big Sky development, and the Beartooth Primitive Area; a wilderness study of the Great Burn area on the Idaho-Montana border, and wilderness treks in the Bob Marshall. These programs involved people from elementary school past college age and from all parts of the country.

Some difficulty has been experienced in one of the most compelling parts of the experiment, the development of an environmentally sound life style. In the pursuit of this and other goals, the Falls Creek program is attracting sympathetic attention as awareness grows that the critical environmental questions of the day require a personal as well as a public commitment.

As noted by Dr. Charles C. Bradley in a recent letter to the Wall Street Journal,

> **It is important to remember that our environmental problems are not some sin committed by the environment. Nor were the problems invented by environmentalists. Environmentalists are just a group of fallible individuals who are rightly worried about what's coming.**

That this environmental response to "what's coming" derives much of its strength from nongovernmental sources is no secret. It is true that environmentalists such as Theodore Roosevelt, Bob Marshall, Olaus Murie, and Rachel Carson were in governmental capacities when some of their best work was done, but individuals before and since — Henry Thoreau, John Muir, Paul Ehrlich, David Brower, among many others — are examples of the extent to which persons outside government can influence environmental sensibility and government action. A host of national groups — the Wilderness Society, Sierra Club, Friends of the Earth, Environmental Defense Fund, Environmental Action, and many more — make daily contributions to the quality of discussion and to necessary action on environmental matters. The continuing task in Montana is to upgrade the quality of environmental decisions with the healthy, if sometimes disturbing, input which only those outside government can offer. Government agencies have proven that they will not and cannot do the job alone.

Industry Efforts

Environmental Protection Activities Of the Agricultural Industry in Montana

Contributed by
Cooperative Extension Service

Agriculture is Montana's leading industry and has a significant influence on the environment of the state. The agricultural sector is engaged in various activities to provide environmental safeguards, including programs of long tenure, others that are being modified and expanded to meet the urgency of the situation, and some new efforts.

Federal Programs

Many of Montana's agricultural activities are assisted financially through the Rural Environmental Assistance Program (REAP), successor to the Agricultural Conservation Program (ACP). REAP is administered by the Agricultural Stabilization and Conservation Service (ASCS) of the U. S. Department of Agriculture (USDA). It is authorized by the Soil Conservation and Domestic Allotment Act, with funds appropriated annually by Congress. The REAP program has focused largely on average or small family farms.

The REAP program is the primary means by which the federal government shares with farmers and ranchers the cost of carrying out approved soil, water, woodland, wildlife conservation and pollution abatement practices on the land. The program's objectives are two-fold: to help maintain the productive capacity of American agriculture and to help assure the nation's growing population an adequate supply of clean water, clean air, natural beauty, and outdoor recreation opportunities.

The REAP program encourages improvement and preservation of environmental quality and ecological balance, as public benefits, through:

Preventing or abating pollution or other environmental degradation.

Preserving open space or enhancing the appearance of areas.

Benefiting wildlife and other desirable life forms.

Preserving historic, archeological, or scenic sites of interest.

Avoiding the creation of hazards to persons or animals.

The highest priority of REAP cost-sharing is given to practices that will result in such public benefits, with emphasis on prevention or reduction of specific, farm-based pollution problems, application of enduring conservation measures, installation of private demonstration projects, assistance to low-income farmers in pollution abatement and conservation practices, and the involvement of youth, minority groups, and individuals in program activities.

Some of the major categories of practices included in the REAP program are: establishment, improvement, or retention of long-lasting, protective soil cover of grasses, legumes, and trees, conservation or safe disposal of water, and interim protection from erosion. Nearly 8,000 Montana farmers during 1971 received nearly $3.5 million in cost-sharing benefits for some 44 varied, agriculturally sound practices. Some newer practices which qualify for cost sharing include animal waste disposal facilities, sediment retention structures, and disposal of woodland residues without burning.

Farmers Home Administration (FHA) cooperates with ASCS to provide financial assistance for certain agricultural endeavors. Of primary importance to environmental safeguards is FHA assistance available to individuals who adjust feedlot operations to meet statutory environmental regulations. FHA also provides funds for irrigation projects that eliminate erosion and subsequent sedimentation.

The Soil Conservation Service (SCS) of the USDA also works closely with the REAP programs on private agricultural problems. The SCS views its role as that of providing technical leadership in the field of conservation, development, and productive use of soil, water, and related resources. With the increasing concern over pollution and interrelated problems, the SCS is shifting its priorities to deal with these issues.

The SCS in Montana works through 58 conservation districts to carry out its program. As of January 1, 1972, district cooperators comprised 14,537 farmers and ranchers controlling 42,901,665 acres of land. Over two-thirds of this total have conservation plans. The SCS program promotes sound agricultural conservation practices to stabilize agriculture and safeguard the environment.

Some recent changes in emphasis by the SCS to meet environmental concerns include the following:

A program has been instituted, based on snow surveys and water supply forecasts, for reservoir management to reduce flood damage, improve downstream fisheries, reduce bank erosion, provide a more dependable water supply, and benefit waterfowl. This approach has been developed for the management of Hebgen, Middle Creek (Hyalite), Cooney, Ruby, Lower Willow Creek, and Bair Reservoirs. It has been partially implemented for Hebgen and Lower Willow Creek. Evaluation of snowfall at proposed ski slopes have been prepared, based on snow surveys. Snow survey information is also being used to predict yields and peak flows from mountainous drainages, as well as for weather modification activities and for monitoring changes in precipitation trends.

Last year, the SCS in Montana initiated collection of snow cores for heavy-metal analysis. Use of snow cores gives a representative sample of the upper atmosphere and represents a six-month accumulation of heavy metals. Samples have also been collected for radiation analysis. A telemetry system is being planned to monitor snow pack, precipitation, and temperature in the higher elevations on a daily basis. The possibility of adding air quality monitoring to this system is also being explored.

A sediment monitoring system has been initiated on Public Law 566 small-watershed projects, which SCS administers. The agency has been investigating yields and peaks of stream flow resulting from watershed logging.

Last year, SCS in Montana completed detailed soil surveys on 2,500,000 acres in Montana. Soil surveys have traditionally been used as a basis for conservation planning. Some of their new and expanded uses include the location of suitable areas for solid waste disposal and for handling sewage effluent. Soil surveys can also help in the identification of areas on which residential, commercial, industrial, and recreational developments are practical as well as areas which are not.

Montana cities and towns have been encouraged to become part of the local conservation district. In many instances this has made possible application of conservation techniques used successfully to control soil erosion on farm lands and to reduce erosion affecting urban communities. Participation in conservation districts by cities and towns has opened the way for use of land resource data prepared by SCS in comprehensive land use planning.

Last year the SCS initiated a flood plain survey on the Gallatin River in the Bozeman vicinity in cooperation with the water resources division of the Department of Natural Resources and Conservation to delineate the flood-plain areas hazardous to housing development and other uses.

With increased growth of the feedlot industry in Montana, the SCS is working closely with developers in pollution control and waste management. This involves site selection, controlled runoff, design and installation of necessary lagoons, and cropping systems to utilize the solid waste from feedlots.

The Great Plains Conservation Program, administered by SCS, was originally focused on control of accelerated soil erosion in the Great Plains. The program was recently expanded to include consideration of wildlife and recreation values and control of agriculturally related pollution such as feedlot wastes.

During 1970, the SCS reiterated and expanded agency policy for identifying, preserving, and improving fish and wildlife resources under Public Law 566 and for interagency planning on these projects. A memorandum clarifying SCS policy on the mitigation of fish and wildlife losses in watershed projects was issued. Policy concerning protection of archeological sites in Public Law 566 areas was re-emphasized.

The SCS has also initiated a policy for minimizing soil erosion and water and air pollution that may result from construction carried out in connection with Public Law 566 watershed projects. Contractors involved with building structures are required to use measures that will minimize or eliminate pollution problems normally connected with construction.

State Programs

In 1970, resource agencies in Montana developed the Montana Rangeland Resource Plan. This plan outlines action needed to protect and enhance range resources. Environmental benefits resulting from the plan should include sediment pollution control, increased recreation potential, and improved maintenance of fish and wildlife habitat.

The Montana Department of Agriculture has implemented guidelines, to be used in conjunction with guidelines of the Montana Environmental Policy Act (MEPA) and Environmental Quality Council, to determine whether actions or proposed actions should be reviewed. To comply with MEPA provisions, the department requires environmental impact statements on all actions that may have a significant adverse effect upon man and the environment, or are environmentally controversial.

Among department programs subject to review are those of the pesticide division, which has expanded importance because of recent pesticide legislation and Presidential executive orders. The pesticide division has authority to restrict pesticide use and is responsible for developing standards for pesticide disposal. Commercial pesticide dealers in Montana now are licensed through the division, and dealers will receive licenses only after they pass an appropriate examination.

Other Department of Agriculture divisions requiring environmental reviews of specific programs include seed and fertilizer, horticulture, grain, and centralized services.

Siltation is the primary source of pollution in Montana waterways. Probably half of the cropland and approximately 30 percent of the rangeland is susceptible to excess sedimentation. Waterways are often silted through sheet, gully, wind, or accelerated streambank erosion, by landslides, or by means of channel-bottom alteration and wave action. Activities that may contribute to this sedimentation problem include grazing, cropping, logging, road construction and alteration, etc.

House Resolution No. 24, adopted by the 1971 Montana legislature, deals specifically with sedimentation problems in one important watershed, the Clark Fork of the Yellowstone River. The resolution directs the Board of Health and Environmental Sciences, Department of Fish and Game, Soil Conservation Service, and Beartooth Resource and Conservation District to study pollution in the Clark Fork caused by present water use practices. Studies are now in progress, and the agencies have held several planning sessions, with coordination coming from the water resources division of the Department of Natural Resources and Conservation.

The Clark Fork Basin drains an area of 2,848 square miles in northwestern Wyoming and southcentral Montana. Its watershed encompasses wastelands and land used primarily for timber production and livestock grazing. These uses, and oil production near the river's headwaters, may add to the pollution of the Clark Fork. The silt load apparently is heavy in the river. Montana irrigates 30,000 acres directly from this river, and Wyoming diverts water to irrigate 10,000 acres. The long-term objective of the study is to find solutions for reducing the siltation. While the parent materials bordering the river may never allow for a complete end to the problem, the silt load may be reduced to a point where water quality is improved downstream.

The agencies and groups involved with the Clark Fork study are required to submit a report to the 1973 Montana legislature on the extent of the problem and to suggest methods of controlling the sources of erosion and sediment that pollute the river. This report will probably include recommendations for modification of agricultural practices in the watershed.

One of the primary sources of air pollution in Montana has been agricultural burning. The Montana Department of Health and Environmental Sciences now implements air pollution standards, including enforcement of new regulations aimed at reducing burning. The department discourages all open burning and is working towards its complete elimination. It recognizes, however, that some agricultural practices require burning as long as strict suppression of other techniques is enforced.

Burning is defined as essential if it is the only way to remove certain materials. Examples of essential burning include burning of irrigation and drainage ditches if the material is dry, sagebrush if it is windrowed or piled, and clean, dry timber slash.

Some other materials may be burned, on certain occasions, if burning is the only effective method of disposal. These include grain stubble and straw bunches too thick to cultivate; garbage, when collection facilities are not available; and miscellaneous agricultural materials such as pruning residues, fertilizer sacks, or animal carcasses when disposal is required for disease control. Clearing of miscellaneous debris also may fall in this category. Weed control requires burning when considered an essential part of agricultural operations.

The Department of Health and Environmental Sciences does not permit burning of any of the following, remnants of hay or straw stacks, rubber materials, old vehicle bodies, garbage dumps, insulated wire, fuels, dead animals except as required for disease control, scrap lumber, buildings, railroad ties, etc. The list includes material that produces offensive or toxic odors.

The department enforces four important points for permitted burning, all of which apply to agricultural operations. (1) Conditions encouraging good smoke dispersion must prevail, this will be determined through reference to the National Weather Service forecasts for acceptable meteorological conditions. (2) Materials to be burned must be dried, piled, and free from foreign debris. (3) All burning must be accomplished between 10 a.m. and 4 p.m. (4) All burning must be confined to materials specified in the permit.

When the meterological situation changes, the department acts to decrease or stop burning. Meterological conditions are then monitored until control can be released. All occurrences and actions taken during the monitoring time are documented, and a final analysis is made for future improvement.

The Department of Health and Environmental Sciences also is drawing up a proposed regulation for control of water and air pollution from confined livestock feeding. The purpose of the regulation is to implement the Water

Pollution Control and Clean Air Acts of Montana as they pertain to this activity. The department will provide guidelines for existing and potential feedlot operators to help them comply with the statutes. Applications must be made and permission to establish livestock waste control facilities must be obtained before the operator starts or becomes further involved in such an operation. This includes a well-defined jurisdiction over enlargement of present facilities as well as new ones.

Education Programs

The U. S. Department of Agriculture has initiated the Environmental Thrust Program, designed to help its personnel coordinate citizen efforts to improve the environment. Though primarily educational, the program will include technical help and advice.

This educational "thrust" will develop teaching materials, help local groups with implementation plans, and assist state and local groups in determining their needs for regulations and standards and in interpreting regulations, etc. It will also assist in developing environmental education programs to change attitudes, and will utilize communication channels to keep individuals informed of relevant developments at all levels of government.

State and federal environmental education programs applicable to Montana agriculture are varied. The subjects covered range from economic considerations to ecological practices relating to a number of agriculturally used ecosystems. Educational programs concerning the use of agricultural chemicals, including pesticides and fertilizers, are conducted throughout the state. Weed districts are encouraged to discontinue noxious weed control along waterways and to direct efforts toward the source of weed infestations rather than secondary areas. Proper fertilizer application is continually stressed.

Work has begun to halt the detrimental effects of saline seep throughout much of Montana's cultivated drylands. The problem is especially serious in the Highwood Bench, a very productive grain-farming area. Saline seep occurs on low sites where soil layers impervious to water lie near the soil surface and salts are deposited. The heavy salt accumulations are caused by excessive amounts of water moving rapidly through nearby cropland, usually summer-fallowed.

Saline seep areas tend to increase in size; it has been estimated that they may grow at the rate of an additional 10 percent each year. The groundwater in these areas is polluted with salt nitrates to the point that it is not good for household, livestock, or recreational use.

The problem now encompasses some 250,000 acres in 25 counties east of the Continental Divide. State geologists estimate there may be eight million acres of potential saline seep in Montana.

A number of agencies are cooperating on research projects and educational programs to halt the spread of saline seep in Montana. Experimental approaches to the problem are: intensive cropping to use the water before it moves below the root zone, flexible or continuous cropping systems; drainage to intercept the water before it forms a seep or drainage of offpocketed water to reduce seep areas, and monitoring water tables and water quality from recently drilled wells.

Because many agricultural uses are integrated into multiple use management plans on public lands, Montana has continuing need for education of both the agriculturalist and the public. This need has been emphasized because of current public concern for the environment, and various state and federal agencies have undertaken the task of promoting the need for land use planning. Educational efforts in this area include information regarding environmental theories and the need for planning, with special attention to the tradeoffs between economics and environmental quality, and the publication of a number of bulletins on the planning issue, its methodology and implementation. A number of meetings on these subjects have been held or are scheduled throughout Montana.

Environmental Protection Activities Of the Petroleum Industry in Montana

Contributed by
Montana Petroleum Association

This report summarizes Montana's petroleum industry activities in environmental protection. The report is in four parts: The first section outlines national activities of the industry and will affect pollution in Montana; subsequent sections cover Montana environmental efforts in the production, transportation, and refining phases of the industry.

National Activities

Organized efforts by the oil industry to deal with pollution problems go back to 1927 when the Committee on Refinery Environmental Control of the American Petroleum Institute (API) was established. The committee's most important single achievement has been the development and continuing revision of the *Manual on Disposal of Refinery Wastes*, which deals with air, water, and solid wastes and presents the current state of control technology.

Other environmentally oriented committees working in the API are as follows:

The Committee for Air and Water Conservation studies all of the institute's conservation efforts and makes recommendations for streamlining and accelerating those efforts. In 1971, $3 million was budgeted for this work.

The Air Pollution Research Advisory Committee of the Coordinating Research Council is a mutual endeavor of the automotive and petroleum industries to improve vehicle equipment, fuels, and lubricants. The committee's purpose is to provide basic information on the nature and effects of air pollution from vehicles. The program covers subjects of interest to both industry and government.

Data acquired from committee investigations are expected to provide industry with the technical information needed to achieve further reduction of emissions through the development of improved equipment and petroleum products. The data are also expected to assist the government in establishing air quality standards and emission control requirements.

The Wildlife Conservation Liaison Committee was formed in 1960 to establish and maintain liaison with national conservation leaders in an effort to resolve major environmental problems.

Production

All-time crude oil production in Montana has amounted to 756,439,825 barrels with a cumulative value of $1,741,167,564.00. The percent of petroleum value to total value of all minerals produced annually is 43.4. The 1971 average daily crude oil production in Montana was 94,791 barrels. The previous year saw a total of 490 wells drilled in Montana; 69 oil, 55 gas, and 366 dry holes.

This section will be confined to a brief outline of the environmental activities of two producers. During February and March, 1972, Cardinal Petroleum Company contributed over two weeks of engineering manpower and stenographic time to the API Subcommittee on Production Waste Disposal. The subcommittee was directed to research, tabulate, and summarize all state and federal regulations covering prevention of air and water pollution by production wastes. The purpose of the project is to make all personnel aware of regulations involving pollution.

With regard to oil spills, Cardinal is currently forming a cooperative committee of industry operators. The committee objective is rapid containment and cleanup of oil spills through use of pooled manpower and equipment.

In 1971 Cardinal drilled six exploratory wells in Fergus County in an unsuccessful attempt to develop the first oil or gas production in that county. Through studies of the exploration area and through control gained from the holes drilled, Cardinal supplied information to hydrologists in the U. S. Geological Survey on potential domestic freshwater reserves.

During February, 1972 Cardinal inaugurated water injection into the Flat Coulee Unit in Liberty County, a project expected to result in the production of 2,512,000 barrels of oil that would not be recovered by conventional recovery procedures. Cardinal also participates as a nonoperating partner in the Red Creek Unit in Glacier County. Here, approximately 2,900 barrels a day of water produced along with oil from the Madison Formation is injected back into the ground into the Cutbank Formation, thereby enhancing recovery from that reservoir.

The Montana operations of another production company, Amoco, include an effort to ameliorate water pollution of the Musselshell River. This company built several dikes to drain the batteries into pits with 6,000-barrel capacities. Amoco then purchased a skimmer pump, skimmed the oil off the pits, and pumped it back into tanks. The pits have been fenced and are both adequate and in good condition. The oil producers have been building additional pits and cleaning up oil that has accumulated over the years.

Transportation

Montana has a number of liquids pipelines transporting crude oil from producing fields to refinery centers and transporting refined products from the refineries to various distribution points (Figure 3). Liquids pipelines in Montana run the gamut from small, short gathering lines to fairly large, cross-country transporters. Their total instate length amounts to 3,000 miles. These pipelines move over 300,000 barrels of crude oil and refined products across the state. The equivalent movement by transport trucks would require about 1,500 (8,400-gallon capacity) vehicles over and above those that are currently on the highways.

Piepline companies have an emergency procedure plan, known as a contingency plan, in the event of pipeline failure. The plan lists telephone contacts for company personnel, contractors in the area with equipment lists, and the various state and federal agencies that must be notified should a spill present a pollution hazard. It is extremely important to get qualified personnel to the site as quickly as possible in order to evaluate the hazard and take appropriate measures in terms of public health and safety. Heavy equipment is used to build temporary dams and diversion ditches; straw is used to absorb spills; and trucks equipped with pumps pick up the spilled materials.

The pipeline companies, in coordination with Continental Pipeline Company, have formed the Montana-Wyoming Oil Control Coordination Committee for the purpose of controlling refinery and pipeline oil spills. The committee includes 10 companies and covers northcentral Wyoming and southern Montana.

Other specific pipeline improvements in the environmental area include:

> **Operation of pipeline systems from traffic control centers on a 24-hour basis. Any abnormal condition in the system alerts dispatchers who can shut down the line if necessary.**
>
> **Regular air patrol of pipelines to detect possible small leaks or locations where surface activity might present a damage risk to the pipeline.**
>
> **Construction of crude oil storage tanks with floating roofs to limit hydrocarbon vapor emissions.**
>
> **Cathodic protection to prevent corrosion of lines and help prevent oil leaks.**
>
> **Installation of pressure relief valves to prevent overpressure of the pipelines.**

Pipeline rights-of-way marked at road crossings and other locations where external damage might occur. Telephone numbers are shown that can be used on a 24-hour basis for emergency notification.

Installation (under construction) of an oil skimmer in Yegen ditch at Billings to prevent oil from escaping into the Yellowstone River.

Moving of an idle line across Cut Bank Creek and completion of a corrosion control program.

Replacement of pipeline after detecting signs of external corrosion before any major leaks develop.

Collection of waste oil or oily water from oil-water separators for handling at major pipeline terminals.

Pickup of any oil in liquid form and return to storage. (It was formerly common practice to burn spilled oil in place if it was not economically feasible to pick up.)

Development of an "oil herder" by Shell Pipeline Research and Development Laboratory to clean up oil spills.

Refining

In an effort to meet environmental improvement responsibilities the refineries of Montana have taken the following action during 1971-1972:

HUMBLE OIL AND REFINING COMPANY

In the treated wastewater system, discharges have been reduced as follows: phenols down 87 percent; oil down 77 percent, biochemical oxygen demand (BOD) down 57 percent. These improvements in water quality were accomplished by (1) adding mechanical aerators and other facilities to the oxidation lagoons and (2) improving operating procedures and surveillance.

Air emissions have also been reduced significantly in several areas, such as: coker carbon monoxide down 99.95 percent, coker stack particulates down 82 percent; cat stack ammonia plume eliminated; hydrocarbon emission down 20 percent.

The 1971-1972 period also saw the startup of several new facilities that contribute directly to improved emissions control. Major projects include a coker CO boiler, flare knockout system, emergency fuel-gas scrubber, LPG fuel vaporization system, and three floating-roof tanks. A new powerformer was also completed during this period that will have an indirect but positive effect on atmospheric pollution. It will expand the ability to manufacture blending components of high octane gasoline to reduce lead in motor fuels.

FARMERS UNION CENTRAL EXCHANGE

Two projects will make it possible to meet some of the requirements of hydrocarbon emission standards. New oil-water separation facilities were installed to replace an API separator of 1940 vintage and improve sewer effluent. New light product truck-loading facilities were constructed.

CONTINENTAL OIL COMPANY

Air quality improvements include: installation of enclosed LPG stenching system, installation of refinery flare liquids recovery system, enclosure of spent caustic collection system, covering on API separator basin per Montana Control Regulation 90-018, and switch to low attrition catalyst to reduce particulate emissions from fluid catalytic cracking unit.

Water quality improvements include: implementation of oil spills contingency plan; installation of oil spill diversion facilities on industrial drain; commencement of extensive wastewater analytical testing program for planning reuse recycle of wastewater streams, experimental facilities for land decomposition of oil wastes; and revision of plant drainage system to eliminate unprocessed storm runoff.

PHILLIPS PETROLEUM COMPANY

Activity in the past few years has been directed toward water quality improvement. Installation of cooling and recycling equipment has resulted in a marked reduction in the amount of water taken from and returned to the Missouri River. Several operating procedures have been revised to protect water quality.

Major water and air pollution control devices at the refinery incluude: a hydrocarbon vapor recovery system on a new gasoline storage tank to meet Montana Control Regulation 90-018 pertaining to storage of petroleum products; equipment that strips hydrogen sulfide and ammonia from the condensate water from the catalytic cracking unit; an oil-water separator that improves removal of oil from refinery wastewater; an air flotation tank that processes the effluent from the oil-water separator, further reduces the oil content of the wastewater, and removes most suspended solids, a biological treatment pond that reduces dissolved organic materials and supplies oxygen to the effluent water; and installations that prevent runoff water outside the refinery from entering the wastewater treatment ponds and thus overloading the system.

By August of 1971 a contingency plan had been developed and equipment purchased to prevent spreading and permit recovery of accidental oil spills on the Missouri River. In response to public concern over objectionable odors from the refinery, control steps have already been taken and further odor reduction measures are planned.

BIG WEST REFINERY

The company installed a new burner-head on flare gas systems, reducing smoke emission through more complete combustion. A new gas recovery system, reducing gas

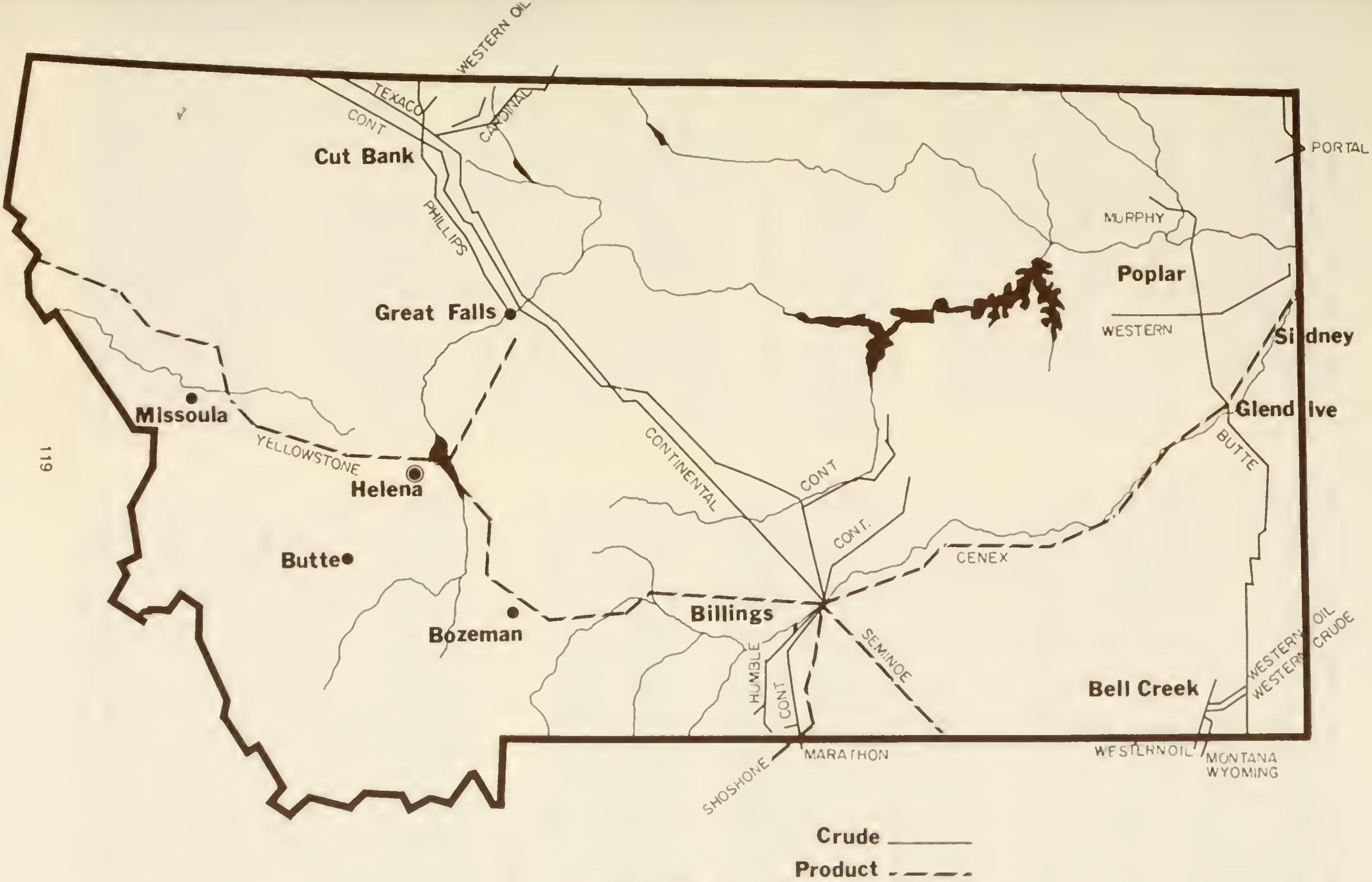

Figure 3: Liquids Pipelines in Montana

burned in flare, was also installed. In addition, an employee training program was instituted to promote caution in handling of crude oil and finished products, and a revamp of the loading rack was started to reduce leakage and spillage.

DIAMOND ASPHALT REFINERY

A fin fan cooler was installed, making it possible to reuse water instead of returning it to the West Fork of the Milk River. Here too an employee training program relating to the handling of crude oil and finished products was initiated.

Diamond Asphalt plans to install a new crude delivery line to the refinery from the adjacent production field. This line, to be completed in 1973, should eliminate the breaks that have been a problem in the past.

WESTCO REFINERY

The company established an employee training program similar to those listed above.

Conclusion

Oil industry expenditures for environmental protection have shown a steady and substantial increase over a five-year period. Nationally, petroleum spending for air and water pollution control has moved from $271.3 million in 1966 to $559.3 million in 1970. The industry has stated its concern for a clean and livable environment, and with improved methods and additional spending it will extend its efforts to insure that it no longer pollutes air and water.

Environmental Protection Activities Of the Wood Products Industry In Montana

Contributed by
Western Wood Products Association

Introduction

The Wood Products Subcouncil of the National Industrial Pollution Control Council has summarized the progress and problems of the industry in the realm of environmental protection. The following excerpts are a relevant introduction to our review of environmental activities of the wood products industry in Montana.

> **The forest products industry has made a great deal of progress in eliminating the environmental problems it helps to create. Some very real advances have been made in improving air and water quality at mill sites. More needs to be done . . . (The industry) has the good fortune of dealing with a raw material which is biodegradable. It creates wastes which are largely nontoxic and noncorrosive.**
>
> **Large, integrated mill operations now are able to utilize nearly all of the coarse and fine wood residues resulting from manufacturing. Small and isolated mills have greater difficulty in disposing of this material and are most often unable to utilize heat for power generation or processing when they burn it. Bark, because it is wet and occurs in huge volumes, remains the largest challenge to the industry's technical ingenuity.**
>
> **Esthetic problems resulting from logging operations are receiving greater attention . .**
>
> **In general, the industry has the capacity to deal adequately with its environmental problems. Requirements for prompt installation of pollution control equipment pose financial problems for some parts of the industry, and federal and state encouragement of additional research may speed solution of certain problems that require technological breakthroughs (1).**

Environmental activities of the industry in Montana are in three broad categories: commercial forestland management, timber harvest, and product manufacture. Our report primarily concerns the period from July 1, 1971 through June 30, 1972.

Commercial Forestland Management

Wood products industries recognize a dual responsibility in forestland ownership: to manage their lands for sustained yields of forest crops and to provide other environmental benefits, tangible and intangible, for the public.

SUSTAINED YIELD OF FOREST CROPS

A tree improvement program is underway in the Northern Rockies with industrial forestland owners, public agencies, and universities cooperating. The program includes testing for genetically superior trees starting with the collection of seed (cones) from specific elite trees in selected stands. In 1971, a total of 234 pounds of ponderosa pine seed were collected, 25 pounds of which were from trees on company lands in Montana.

Many overstocked timber stands need thinning, which not only increases the fiber growth on the remaining trees but provides more sunlight stimulus for understory vegetation. During 1971, approximately 7,700 acres of overstocked private forestland in Montana were thinned, including 4,375 acres of industrial forestland (3).

Natural regeneration methods are favored for commercial forestlands not adequately stocked with trees. Proper silvicultural and logging systems are planned to this end. If areas where timber is harvested are not reforested naturally within five years, other methods are employed. Industry foresters in 1971 planted 2,530 acres to seedlings, direct-seeded 1,940 acres, and prepared sites for natural regeneration on 4,740 acres of company land (3). The St. Regis Company at Libby maintains a nursery where it raises seedlings from locally collected seed.

Prevention of man-caused wildfires and suppression of all fires are an important activity of the wood products industry. All industrial lands are protected by one of the resource agencies, and companies conduct fire prevention campaigns among employees and local residents. Company fire crews are organized and suppression plans prepared at the beginning of each fire season.

WILDLIFE AND RECREATION

Cooperative studies and agreements with wildlife agencies generally relate to populations and habitat. Eighty miles of company roads have been closed to reduce pressures on wildlife. Road closures lead to conflicts in public opinion, however, because roads built to harvest timber on company lands have traditionally been open to public use.

With minor exceptions, industrial forestlands are open for public recreation, mostly in the form of touring, picnicking, hunting, and fishing. No fee is charged for use of the improved campgrounds.

Timber Harvest

Well-planned and well-executed programs can reduce the environmental impact of timber harvest, including road construction. Although reductions in portions of the forest canopy through logging may be displeasing, they tend to perpetuate seral stages resulting from past wildfires and other natural agents.

ROADS

According to the policy of industrial forestland owners,

> **Roads shall be planned, located, and constructed to provide a minimum disturbance of the land for the standard of road required. They shall be designed and constructed to minimize erosion and stream siltation.**

Various practices are used to control dust and erosion. One company oiled 98 miles of logging road and applied 16,500 pounds of grass seed on newly constructed roadcuts and embankments.

SILVICULTURAL SYSTEMS IN HARVEST PLANS

Partial cuts, shelterwood, and seed-tree cutting are favored systems. Clearcutting is used only when compelling reasons require this method. Data are not complete, but we estimate that clearcuts comprise one to 10 percent of all industrial forestlands that have been logged.

LOGGING EQUIPMENT AND TECHNIQUES

On steep terrain, the trend is toward fewer roads and more line-skidding equipment. Various new machines have increased yarding distances, including skyline equipment that can reach out 1,000 feet and lift large logs, and smaller, lighter machines capable of line-skidding small logs for a distance of 400 to 600 feet. Several of the small machines are in Montana but only three of the large skyline yarders. Both types reduce environmental impacts in the forest. Logging with these systems costs from one and a half to two times that of previous systems.

Tree shears and feller bunchers are used on favorable terrain in small-diameter stands, generally overmature lodgepole. Lower stumps and smaller top-diameter utilization result from this combination.

Crews have been instructed to use care in logging, especially along stream courses. Recent instructions from one company read

> **All trees designated for cutting within 100 feet, on each side, of designated live streams will be felled directly away from stream and line-skidded away from the stream protection area. All debris that is placed in the streams will be carefully removed. Material that is already present in stream will be left undisturbed.**

UTILIZATION

In 1969, Montana had an estimated 86.4 percent of total removals from growing stock that went into roundwood products. The remaining 13.6 percent is currently left in the woods as logging residues (4). Utilization of formerly uneconomic portions of the tree is increasing as conventional markets improve and new products and byproducts are introduced. Smaller logs than formerly are now merchantable and logs too defective for sawing and peeling can be harvested for pulp. (The pulp market is very recent and spasmodic, but should improve.). Also, industrial landowners are intensifying their salvage programs as recovery of dead and dying trees becomes possible through better access.

Hoerner-Waldorf, Anaconda Forest Products, and a machinery manufacturer have studied the feasibility of using portable debarkers and chippers in the woods. Chips produced were satisfactory for pulping, but the delivered costs were much higher than those of chips available from other sources. More work needs to be done in this field, especially in the reduction of logging costs for very small logs.

SLASH

Slash disposal is necessary to reduce fire hazard and prepare the seedbed for regeneration. The amount to be disposed of depends on the type of silvicultural system used, care taken in logging, and utilization. The greatest slash disposal problems are encountered when overmature, defective, disease- or insect-ridden stands are clearcut. Young merchantable stands that have been lightly thinned produce the least residue and many require no treatment.

Fire is the most practical disposal agent for large accumulations of slash. On-site chipping of residues has been investigated (see above), and generally found to be economically and ecologically unfeasible; small amounts of chipped slash can be absorbed naturally in most ecosystems but large amounts create additional problems. With more complete utilization of tree parts, slash disposal and smoke problems will decrease. As far as we can determine, baseline data on particulate fallout, etc., are not available for slash burned on private lands.

Product Manufacture

Environmental protection activities in forest products manufacture can be broadly grouped into reduction of residues through increased production utilization and reduction and control of pollutants from manufacturing processes.

INCREASED PRODUCTION UTILIZATION

Sawmills and planing mills, plywood and millwork plants, and post and pole yards are primary manufacturers. For this production group, raw material is generally in log form, except in the case of planing mills and millwork plants without sawing facilities.

In primary manufacture, utilization, especially of small-diameter logs, has been increased through the introduction of more sophisticated equipment such as the various chip-n-saw mills. Thin kerf saws, finger-jointing of short lumber, and lamination techniques have extended the use of the log. Segregation of logs by size and quality to obtain maximum utilization is also practiced, and we look forward to further refinements, including computerized log positioning to maximize production from the delivered log. Two plants attached to sawmills are producing compressed fuels from mill waste, and one plant manufactures an industrial gum (Stractan) from larch residues.

Pulp and paper plants and particle board plants are secondary manufacturers. The two installations in Montana use as their basic raw material wood chips, shavings, and sawdust obtained from sawmills and plywood plants. Residues that formerly went up in smoke are now being converted into useful products.

The Hoerner-Waldorf pulp mill near Missoula recently installed a debarker and chipper to fill short-term raw material needs by utilizing dead trees not suitable for lumber or plywood. This plant also uses hogged mill waste for steam production. The particle board plant, also in Missoula, is constructing a steam plant for utilization of residues.

REDUCTION AND CONTROL OF MANUFACTURING POLLUTANTS

Air quality: The most pressing problems are smoke, particulates, or odor from tepee burners, boiler systems, and pulp manufacturing.

A 1968 survey by the Montana Department of Health and Environmental Sciences revealed 88 tepee burners in operation, none of which were capable of meeting state emission standards. By May 1970, 54 of these burners remained and were being examined for compliance. At the beginning of 1972, 48 burners were still operating, of which eight were not always in compliance with regulations.

The costs of meeting state requirements varied tremendously, from a low of $1,600 for revising a small tepee burner to a high of $1,500,000 for replacement by a boiler system. Some of the boiler installations are being further refined because of inability to meet state or county regulations.

The 28 companies who responded to a recent statewide questionnaire reported a total of 29 tepee burners prior to 1968. Of these, 12 have been revised and five replaced by new burners, seven have been eliminated by boiler systems, four by landfills and other uses, and one by mill closure.

Prior to construction of the pulp plant in 1957 virtually all residue was unused and disposed of by burning. With the pulp plant in operation and production increasing, unused residues, excluding bark, decreased from 72 percent in 1962 (2) to 26 percent in 1969 (4). Estimates of bark residues were first made in 1969 when 72 percent of the total bark generated was unused. Including bark, approximately 37 percent of plant residues, by volume, were not used that year. More recent data are not available, but we estimate that at the end of 1971 less than 20 percent of total plant residues were not being utilized. With strong possibilities for the construction of two more particle board plants in western Montana, the use of tepee burners should continue to decline.

The 15 major wood residue boiler systems in the state are meeting particulate emission standards through the use of scrubbers. The two plants which do not meet these standards are being modified.

In 1970 Hoerner-Waldorf embarked on a two-phase air pollution control program. Phase I involved adapting a newly developed low-odor chemical recovery and electrostatic precipitator to the largest of three recovery furnaces. This was designed to bring emissions from the furnace within state standards for particulate collection and within expected standards for total reduced sulfur (TRS) emissions. Phase I also involved the addition of water scrubbers to the hogged fuel boiler. These modifications were completed in August of 1970, and test data revealed the unit to be well within established emission standards.

Modifications to number three recovery furnace was completed in April of 1971. Extensive emission testing on the modified furnace during May and June revealed that it is capable of operating with TRS below the daily average concentration of 17.5 ppm as specified in Regulation 90-008, effective November 30, 1972; that emissions of sulfur dioxide from the modified furnace are negligible; and that the measured particulate collection efficiency of the electrostatic precipitator ranges between 93 and 95 percent, substantially below the level of over 99 percent guaranteed by the manufacturer. Following many additional modifications, tests in 1972 revealed the unit to be operating at 98-percent efficiency. Further improvements are sought.

The installation of necessary equipment to bring the entire Missoula mill into compliance with state emission standards is progressing. It is anticipated that Phase II will be operational by the end of October, 1972.

The particle board plant had the most advanced air pollution control measures incorporated in its construction and is performing satisfactorily.

Water quality: Meeting state water quality standards has been less of a problem for the wood products industries than meeting air standards. Water quality tests as required for federal discharge applications have been made and, where necessary, weekly measurements are taken of influent and effluent.

Outflows from log storage ponds and sewage disposal plants have been brought into compliance through construction of settling ponds and trash racks for the former and secondary treatment or chlorination for the latter. One operator filled his pond and went to dryland storage, in another instance, separate storm sewers were constructed. Most of the plywood plants and sawmills are recycling the wastewaters used in their processes. The pulp mill recently increased its holding-pond capacity and installed clarifiers, and water discharges now meet state standards.

Conclusion

The forest products industry is Montana's largest employer in the manufacturing segment. Intensive forest management, and increased utilization using the most advanced techniques, with recognition of maintaining environmental quality, will enable the industry to increase its contribution to the state.

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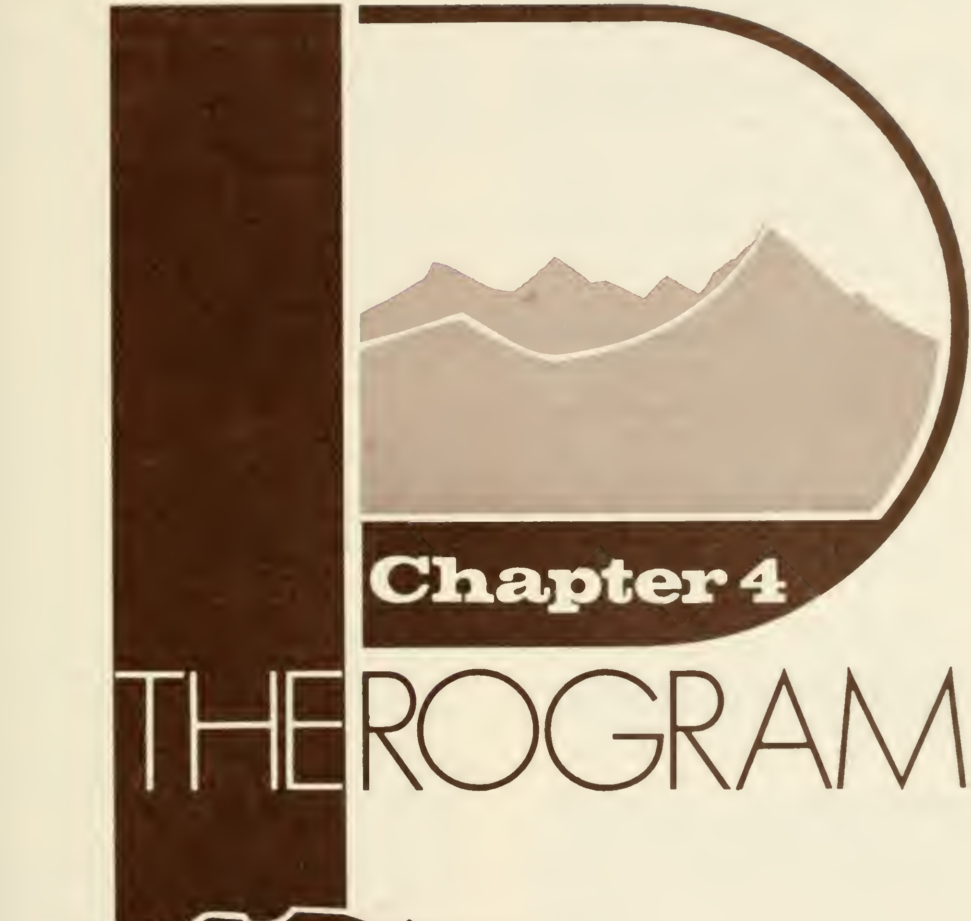

Chapter 4

THE PROGRAM

Introduction

This chapter reviews the major activities of the Environmental Quality Council (EQC) at the end of its first year. The 13-member council created by the Montana Environmental Policy Act (MEPA) was organized on July 7, 1971. Its executive director was appointed on September 1 and implementation of MEPA began immediately. On October 7, 1971 interim guidelines for the preparation of environmental impact statements (EIS) were promulgated under Section 69-6504 of the act and distributed to state agencies, boards, commissions, and institutions. Revisions of the interim guidelines were adopted by the council on July 21, 1972. (See appendix for copies of MEPA and revised guidelines.)

EQC operations covered in this chapter all involve implementation of MEPA as required by various sections of the act. The first part, council operations, includes a review of internal procedures in accordance with Section 69-6504, a reporting section in accordance with Sections 69-6504 and 69-6505, and a description of the council's role established by Sections 69-6514 through 69-6517.

As also required by Section 69-6514, the chapter contains a review of the environmental programs and activities of state agencies. Although only some are covered in this first report, review of all state agencies will be an ongoing function of the EQC to ascertain the quality of environmental decision-making.

The final portion presents staff investigations, another duty stipulated by Section 69-6514. A report on coal/energy development, one of the most serious and immediate environmental problems confronting the state, is included, as is a study on spray irrigation of wastewater, a waste disposal alternative that could have beneficial applications in Montana.

The EQC investigation of subdivision land development, a current environmental problem as critical as coal/energy development, could not be completed in time for inclusion in this report. William D. Tomlinson's study of the proliferating activity in land subdivisions, and the statutory and regulatory considerations relating to such activity, will be distributed as a separate EQC publication in the near future.

EQC Operations

[illegible] to agencies under the interim guidelines was preparation of internal procedures for meeting the requirements of Section 69-6504.

Internal Procedures

Internal procedures, as required by the EQC, [illegible] of numerous agencies [illegible] comprehensive procedures for some of the larger agencies having major environmental responsibilities or impacts. Examples of the former are the Department of State Lands and Natural Resources and Conservation. Other agencies such as the Department of Planning and Economic Development, the [illegible], the Department of Administration, and the Department of [illegible] [illegible] process, requiring preparation of environmental impact statements, [illegible] the EQC [illegible] internal procedures are the Department of Natural Resources and Conservation, Department of Montana Fish and Game, the Department of Livestock, and the Cooperative Extension Service.

One of the functions of the EQC is to give specific guidance in the improvement of internal procedures. The EQC has worked with the agencies both informally and formally in this respect and will continue to do so.

Agencies sometimes lack certainty in deciding actions for which formal statements are required. They also request advice as to the scope of environmental impacts to be considered. Although agencies have been advised to consider secondary impacts in addition to primary, these have not been well covered. In this regard the [illegible] in the [illegible] "Primary effects generally cause primary impacts and secondary effects generally cause secondary impacts." It may be recalled [illegible] the intent of the act it is important to identify the long-term, accumulated consequences of a proposed action as well as the short-term, immediate consequences.

Another difficult but essential challenge in the development of internal procedures has been the MEPA directive

> . . . to develop methods and procedures which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations.

Despite some efforts, progress in compliance with these directives has been insufficient.

Howard T. Odum, a renowned professor of environmental engineering, has discussed the "replacement value of ecosystems." He notes that many public actions are justified with cost-benefit ratios in a way that ignores values that cannot be reduced to monetary terms. This is especially true in the case of industrial developments competing with existing natural values:

> . . . the wilderness values are underappraised because they have no easily recognized dollar value that can be compared with the figures available for the proposed new enterprise . . .
>
> Perhaps the energetic common denominators can be employed to evaluate all uses in the same terms so that planning boards can act fairly, protect the public interest, and develop patterns for the energy network that is best for man's survival (4).

This methodology involves placing dollar values on ecosystem energies using the dollar/calorie equivalent of the entire economy. Using such an equivalent, nature's own metabolic budget — the work nature does for its own maintenance — can be included in economic evaluations. For example:

> To replace complex, diverse, and beautiful forest requires about 100 years. The photosynthesis per square meter of a forest may be approximately 40 kcal/m² (day). The dollar equivalent of work driven by organic fuels is about 10,000 kcal/dollar. With 4047 m²/acre the dollar value of replacement of an acre of this forest is $585,000 per acre. Losing the development value of 100 years for an acre of land is a major loss. A single tree of about 100 years of age is estimated in this way to be worth $3,000 (4).

Although reduction of environmental values to easily recognized quantities is helpful, it does have limitations. Most obvious is the fact that complex natural systems are stripped of their character to enable such monetary comparisons. An additional essential approach is to develop a land ethic that will permit comparisons to be made on the basis of environmental sensitivity as well as economic evaluation.

The Department of State Lands has used such an approach in its recreational potential evaluation system. The general method of the system is:

a. Recreational values increase with the degree of variety of topography and vegetation on a parcel.

b. Esthetic values increase with the degree of isolation of a parcel.

c. Considerable agricultural parcels have values, but are not usually valued in comparison to other recreational parcels.

d. Considerable flat parcels are not as valuable as parcels with many features present.

e. All live streams and lakes have value regardless of surrounding use and vegetation cover.

f. Any evidence of recreational use on a parcel, other than hunting, means that citizens have placed a special value on the parcel (2).

State agencies will have difficulty in arriving at environmental analyses. Both quantification and sensitivity methods are largely undeveloped. The need is to elevate presently unquantified environmental values to partnership with economic and technical considerations. In doing so, effective use of quantitative methods will — and certainly not the least benefit — [illegible].

Environmental Impact Statements

Section 69-6504 (b) (3) of MEPA directs all agencies of the state of Montana to prepare detailed statements on proposals for projects, programs, legislation, and other major actions of state government significantly affecting the quality of the human environment.

The EIS must cover the following:

> Description of the proposed action in sufficient detail to enable a reviewer to grasp the essence of the action.
>
> Environmental impacts, primary and secondary, beneficial and adverse. Adverse impacts that cannot be avoided should the proposal be implemented must be specifically identified.
>
> Consideration of reasonable alternatives.
>
> Relationship between local short-term uses of the environment and maintenance and enhancement of long-term productivity.
>
> Irreversible and irretrievable commitments of resources.

As of June 30, 1972 agencies had filed 14 EIS's covering a wide range of actions. Four agencies have filed a total of 32 negative declarations (see appendix). The negative declaration means that the agency evaluated the environmental effects of the proposed action and concluded that the impacts were insignificant or nonexistent.

In effect, preparing the environmental impact statement requires the agency proposing the action to give speci-

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EQC Operations

One of the first actions taken by agencies under the interim guidelines was preparation of internal procedures for meeting the requirements of Section 69-6504.

Internal Procedures

Internal procedures submitted to the EQC vary from those of extreme simplicity to carefully prepared, comprehensive procedures for some of the larger agencies having major environmental responsibilities or impacts. Examples of the latter are the Departments of State Lands and Natural Resources and Conservation. A few agencies such as the Department of Planning and Economic Development, the Bureau of Mines and Geology, the Department of Administration, and the Department of Military Affairs responded to the effect that they undertook few if any actions requiring preparation of environmental impact statements. Agencies that probably will need to file EIS's but have not yet submitted internal procedures are the Department of Planning and Economic Development, the Bureau of Mines and Geology, the Department of Livestock, and the Cooperative Extension Service.

One of the functions of the EQC is to give specific guidance in the improvement of internal procedures. The EQC has worked with the agencies both informally and formally in this regard and will continue to do so.

Agencies sometimes desire assistance in defining actions for which impact statements are required. They also request advice as to the range of environmental impacts to be considered. Although agencies have been advised to consider secondary impacts in addition to primary, these have not been well defined. In this regard the concept advanced by the General Accounting Office that ". . . project inputs generally cause primary impacts and project outputs generally cause secondary impacts" (1) may be helpful. To accomplish the intent of the act it is important to identify the long-term, unintended consequences of a proposed action as well as the short-term, intended consequences.

Another difficult but essential challenge in the development of internal procedures has been the MEPA directive

> . . . to develop methods and procedures which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations.

Despite some efforts, progress in compliance with these directions has been insufficient.

Howard T. Odum, a renowned professor of environmental engineering, has discussed the "replacement value of ecosystems." He notes that many public actions are justified with cost-benefit ratios in a way that ignores values that cannot be reduced to monetary terms. This is especially true in the case of industrial developments competing with existing natural values:

> . . . the wilderness values are underappraised because they have no easily recognized dollar value that can be compared with the figures available for the proposed new enterprise . . . Perhaps the energetic common denominators can be employed to evaluate all uses in the same terms so that planning boards can act fairly, protect the public interest, and develop patterns for the energy network that is best for man's survival (4).

This methodology involves placing dollar values on ecosystem energies using the dollar calorie equivalent of the entire economy. Using such an equivalent, nature's own metabolic budget — the work nature does for its own maintenance — can be included in economic evaluation. For example:

> To replace complex, diverse, and beautiful forest requires about 100 years. The photosynthesis per square meter of a forest may be approximately 40 kcal/m² (day). The dollar equivalent of work driven by organic fuels is about 10,000 kcal/dollar. With 4047 m²/acre the dollar value of replacement of an acre of this forest is $595,000 per acre. Losing the development value of 100 years for an acre of land is a major loss. A single tree of about 100 years of age is estimated in this way to be worth $3,000 (4).

Although reduction of environmental values to easily recognized quantities is helpful, it does have limitations. Most obvious is the fact that complex natural systems are stripped of their character to enable easy monetary comparison. An additional essential approach is to develop a land ethic that will permit comparisons to be made on the basis of environmental sensitivity as well as economic evaluation.

The Department of State Lands has used such an approach in its recreational potential evaluation system. The general outlook of the system is:

a. Recreational values increase with the degree of variety of topography and vegetation on a parcel.

b. Esthetic values increase with the degree of uniqueness of a parcel.

c. Completely agricultural parcels have values, but are not highly valued in comparison to other nonagricultural parcels.

d. Completely flat parcels are not as valuable as parcels with more terrain variety.

e. All live streams and lakes have value regardless of surrounding use and vegetation cover

f. Any evidence of recreational use on a parcel, other than hunting, means that citizens have placed a special value on the parcel (3).

State agencies will have difficulty in arriving at environmental analyses. Both quantification and sensitivity models are largely undeveloped The point is to elevate presently unquantified environmental values to partnership with economic and technical considerations. In doing so, reduction to easy quantities is not the only — and probably not the most fruitful — approach.

Environmental Impact Statements

Section 69-6504 (b) (3) of MEPA directs all agencies of the State of Montana to prepare detailed statements on proposals for projects, programs, legislation, and other major actions of state government significantly affecting the quality of the human environment.

The EIS must cover the following:

> **Description of the proposed action in sufficient detail to enable a reviewer to grasp the essence of the action.**
>
> **Environmental impacts, primary and secondary, beneficial and adverse. (Adverse impacts that cannot be avoided should the proposal be implemented must be specifically identified.)**
>
> **Consideration of reasonable alternatives.**
>
> **Relationship between local short-term uses of the environment and maintenance and enhancement of long-term productivity.**
>
> **Irreversible and irretrievable commitments of resources.**

As of June 30, 1972 six agencies had filed 64 EIS's covering a wide range of action Four agencies have filed a total of 52 negative declarations (see appendix). The negative declaration means that the agency evaluated the environmental effects of the proposed action and concluded that the impacts were insignificant or nonexistent

In effect, preparing the environmental impact statement requires the agency propoosing the action to give good-faith consideration to environmental consequences at the earliest possible point in the decision-making process. The National Environmental Policy Act (NEPA), upon which MEPA is modeled, " mandates a rather finely tuned and 'systematic' balancing analysis in each instance," as the *Calvert Cliffs* court decision noted. Agencies that have integrated the EIS into existing review processes have found it an effective aid. Speaking of the national act, Timothy B. Atkeson, general counsel of the federal Council on Environmental Quality, said "NEPA only requires what should already be implicit in the notion of responsible decision-making" (2). Agencies that wish to minimize or ignore the environmental effects of their actions naturally consider the process irritating and burdensome.

Agencies can also use the EIS to achieve greater public participation in decision-making. Disclosure of proposed actions through distribution of EIS's to interested publics and the press can bring valuable input and accomplish better citizen rapport. The EIS is an effective public information vehicle prior to public meetings and hearings.

Whether or not a hearing may be called, the agency preparing the statement is responsible for making a draft available to the public for review and comment. Any individual or organization may express support or opposition, suggest additional alternatives, or provide other input that may be lacking in the draft.

Agencies usually allow 30 to 45 days for comment. In some cases notification of availability of draft statements is not adequate. The EQC recognizes that further effort on its own part and that of the agencies is needed in this regard. The revised guidelines provide for early notification in cases where controversy is anticipated.

Although MEPA directions apply to state agencies, private sector enterprises are affected in cases where a proposed action requires a license, permit, lease, or other entitlement from the state. If the action is controversial or significantly affects the human environment, the involved agency must prepare an EIS. In most cases the agency will require the applicant to submit an environmental impact analysis of the proposed action, which is used in preparing the EIS submitted to the EQC. Examples of this procedure include information supplied by subdividers and land developers to the Department of Health and Environmental Sciences pursuant to its authority to regulate water and sewage problems of such developments.

Agencies are finding the EIS a valuable means of drawing upon the expertise of other agencies as a source of constructive criticism and creative suggestions. In a letter to the EQC concerning the Beartooth State Recreation Area EIS, James Posewitz, administrator of the environment and information division of the Department of Fish and Game wrote: "Comments received from a variety of agencies certainly assisted in improving the project, and we thank all respondents." Distribution of EIS's is a means of coordination not only with state agencies but also with federal agencies and with local government units and citizen groups. The Department of Natural Resources and Conservation EIS for the Squeezer Meadows timber sale is an example of the broad range of expertise and public involvement that can be included in the EIS process: comments were solicited and received from Region 1, Forest Service, Flathead National Forest supervisor's office; Departments of Fish and Game, Planning and Economic Development, Agriculture, and Health and Environmental Sciences (water quality and air pollution control bureaus), Montana Wildlife Federation, Swan Valley Citizens Conservation Council, Flathead Wildlife, Inc., and Student Environmental Research Center (University of Montana).

The MEPA requirement that agencies give good-faith consideration to environmental consequences of proposed actions applies even to proposals that may not result in preparation of an EIS. In some cases interagency conferences have led to modifications of plans before an EIS is drafted — modifications that may reduce the action's environmental effects to the point where a statement is not required.

The process of environmental impact analysis is still in its infancy. Attempts to comply with the EIS requirement have often been uncertain and incomplete. More work is needed to insure that all agencies adopt an environmental perspective in their actions — not just in connection with specific projects but in relation to basic policies and program structures. Lack of environmentally trained personnel and adherence to old decision-making habits remain problems. In some instances the EIS is an after-the-fact exercise used to justify decisions already made. Consideration of alternatives is frequently inadequate, and rarely is the ultimate alternative — taking no action at all because of environmental consequences — considered. Certainly the elevation of environmental considerations to full partnership with technological and economic factors in state decision-making has not yet been fully achieved.

Agencies have encountered some problems in the application of MEPA's EIS requirements to specific proposals, problems which the EQC has attempted to resolve through issuance of its revised guidelines (see appendix). It is impossible, however, to anticipate all specific problems. The responsiblity for detailing the way in which each agency will comply with the act ultimately rests with the agency itself.

In evaluating experience with the EIS, it is important to recognize the unique nature of the requirement. Agencies must now not only advocate but openly engage in self-criticism. Adverse impacts must be delineated and alternatives candidly assessed. None of this has been easy, nor will it be in future. But as time passes and more experience is gained by all concerned, the impact process will function more smoothly and become even more valuable in state policy-making.

Statutory and Administrative Review Under Section 69-6505.

One of the requirements of the Montana Environmental Policy Act is that all state agencies review their "statutory authority, administrative regulations, and current policies and procedures" to determine whether any inconsistencies prevent full compliance with the act. Section 69-6505 further requires that this review be submitted to the governor and the Environmental Quality Council by July 1, 1972.

The EQC is not satisfied with most of the responses to this requirement on file by the July 1 deadline. Many agencies seemed less than enthusiastic about carrying out the review, and some responses consisted of flat declarations that the agency's governing statutes and accompanying regulations were not inconsistent with the purposes of MEPA. No attempt was made to discuss the statutes and regulations item by item, nor were they even listed.

Few agencies proposed, as Section 69-6505 requires, "such measures as may be necessary to bring their authority and policies into conformity with the intent, purposes, and procedures" outlined in MEPA. It is possible of course, that only a few agencies have conflicts with MEPA purposes, but statements that this is the case are unpersuasive without a full discussion of the statutes, regulations, policies, and procedures involved.

Even more disappointing was the fact that some state agencies had not responded at all by the July 1 deadline. These were the University System, the Montana Aeronautics Commission, the Agricultural Experiment Station, the Cooperative Extension Service, and the Department of Institutions.

None of this is to say that no agencies submitted a satisfactory review. A number did, and the EQC found their comments and suggestions very helpful. Unfortunately, these agencies were in the minority.

One reason for the lackluster response thus far may be the dearth of proper personnel for the "systematic, interdisciplinary approach" to environmental problems mandated by MEPA. In essence, the act requires state agencies to become introspective, a process that requires adequate staff and time. Even large agencies whose activities involve major environmental impacts often do not have the necessary variety and number of personnel. The State Department of Highways, for one, has recognized its staff shortcomings and has expressed a desire to remedy the situation. Thus the poor response to the requirement for administrative and statutory review may be a symptom of another, more serious problem.

The process of statutory and administrative review should be as useful to the agencies themselves as is the submission of such a review to the governor and the EQC. It should afford an opportunity for reflection and for reassessment of an agency's policies and goals, it could provide a base from which to develop new programs, propose needed legislation, and determine adequacy of staffing. Hopefully, the agencies that have not yet fully complied with Section 69-6505 will move quickly to do so

EQC as Environmental Advocate

As is usually the case with a newly created state agency, uncertainty exists about the role of the Environmental Quality Council. The council cannot properly be called a regulatory agency because it does not "regulate" — in the common meaning of that term — any particular area of public or private business Perhaps it can best be described as an official environmental advocate Of all the organs of state government, the council is the only one specifically created to speak for the preservation of environmental values

EQC staff duties, as listed under Section 69-6514 of the Montana Environmental Policy Act, are largely those of investigation, analysis and recommendation. The council's policing functions are limited to Sections 69-6504 (b) (3) (requirement of impact statements for environmentally significant actions) and 69-6505 (requiring state agencies to review statutory and administrative policies). It is therefore unable to bring traditional legal sanctions against agencies reluctant to adopt an environmental perspective in a given instance It can, however, with the aid of a concerned citizenry, bring much public pressure to bear upon lax agencies. And it can, through normal governmental channels, seek to persuade such agencies to do better without resort to public pressure

One of the council's chief responsibilities is maintenance of a policy overview of state programs having environmental consequences. This includes formulating recommendations to integrate and better coordinate the various state programs already in effect as well as recommending new policies and programs.

Implicit in MEPA is the recognition that for too long state agencies have been making decisions affecting the environment with a minimum of public participation Thus public involvement has become necessary in all levels of environmental decision-making. As noted previously, the environmental impact statement is a giant step towards meeting this need in that information heretofore unavailable is now subjected to public scrutiny In addition, the EQC maintains public files that may be examined by anyone concerned. All this serves to keep decision-makers more aware of their responsibilities and obligations to the public.

If an individual or group has a complaint or a proposal about an environmental program or action, the council is available for consultation If necessary the complaint or proposal will be brought to the attention of the appropriate state agencies and officials for possible action It may be determined that an EIS should be filed or that a change of policy is in order If nothing else, the complaint or proposal can be introduced into the public forum for widespread discussion

Despite its youth the EQC has already injected itself into numerous issues at the request of various legislators, private citizens, agencies, and organizations. Such investigations have involved complaints of water quality degradation from feedlots, highway bridge studies, environmental hazards at Libby Dam, utility transmission-line routing, construction of steam-generating plants at Colstrip, drainage of wetlands, oil seeps and spills, land development activities, and highway routing.

The EQC's main allies in the quest for a quality environment are concerned individuals both within and without state government. Because it has a limited staff, the council cannot hope to be aware of every environmental issue confronting the state but must of necessity rely on a continually alert and informed citizenry. With this kind of help, greater harmony can perhaps be achieved not only between the people and their environment but also between the people and their government.

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State Agency Programs and Activities

This section is a review of the main environment-related programs and activities of the following state departments: Health and Environmental Sciences, State Lands, Agriculture, Planning and Economic Development, Natural Resources and Conservation, and Fish and Game. Time and space restrictions and continuing growth of the executive branch limit this section to a surface treatment. In future, state agency programs — especially problem areas — should be reviewed in greater depth.

Department of Health And Environmental Sciences

An analysis of the department's programs can begin with solid waste management and a peculiar statute still on the books (though probably no longer applied). Section 26-402 of the Montana codes provides that beaver dams which back up municipal sewage drained in rivers to the point where a public health problem is created should be blasted to permit the sewage to flow freely downstream. To a person with even a mild case of environmental awareness the law seems ridiculous. However, it is typical of environmental problem-solving of an earlier era when the relationship between public health and environmental quality was not appreciated.

Solid Wastes

Substantial numbers of the public and various governmental quarters often reflect the above attitude toward what is misnamed the refuse *disposal* problem. Only the most obvious symptoms of the solid waste problem are currently the focus of concern and effort at state and local levels in Montana. The majority of refuse disposal sites in the state are still open dumps (4). Most of these are sources of health and safety hazards, examples of needless land pollution, and contributions to air pollution when they burn. They can harbor disease-carrying pests, pollute nearby lakes, streams, and groundwater, and deflate the value of the land on which they are situated.

The current solution to this problem, and the thrust of existing refuse disposal laws and regulations, is conversion of open dumps to sanitary landfills. To aid rural areas in accomplishing such conversion, joint refuse districts were permitted by the 1971 legislature. Sanitary landfill techniques are well established; information on them is readily available to anyone serious about the prospect. Some success has been achieved in Montana, with approximately 55 percent of the population using sanitary landfills, mostly in large communities. Statewide, however, only about 60 of the 514 communities have landfill sites (4).

Essentially, the sanitary landfill alternative does not get to the root of the problem but barely treats a symptom. Although disposal of garbage in open dumps creates immediate, obvious health and economic problems, burial of garbage is only a short-term solution. In some cases a landfill is not really sanitary. In several states, for example, phenols in plastics have polluted groundwater.

An increasing body of literature is focusing on alternatives to refuse disposal. These include reusing, recycling, and reprocessing products and reducing excesses in production and consumption. Recycling is the ultimate answer to needless depletion of natural resources and the disposal of materials that can be reused or reintroduced into natural cycles with minimal impact. However, even with the mounting concern, the rates for paper recycling are approximately the same as in World War II (24). In fact, the reuse of paper residuals as a percentage of total paper production is declining because contamination of paper products with plastics and metals is increasing, thereby making it more difficult to reuse the material. There is clearly no nationwide or statewide commitment to the recycling of natural resources.

Technology for the collection, separation, and reprocessing of refuse is still in the experimental stage but looks fairly promising. A $2 million hydrapulper operating in Ohio handles 50 tons of refuse daily and yields nine tons of reusable paper fiber, three and one-third tons each of glass cullet and ferrous metals, and one-quarter ton of aluminum. This total amounts to nearly a third of the original volume of refuse (15). An operation in California burns

400 tons of refuse per day — the amount produced by 160,000 people — and produces 15,000 kilowatts of electrical energy. This figure represents five to 10 percent of the power that the same number of people consume in a day (24). Technological complications still exist, such as costs and effluents, and reduce the possibility that these advances will be widely used in the near future, but at least the direction is toward a sound solid waste program.

From the above it should be clear that the most difficult questions about solid waste remain to be asked and answered. But in terms of environmental health and long-range human survival, those very questions are the only ones worth answering. In the dilemmas of solid waste management — one of the main problems of the Department of Health and Environmental Sciences — the continued emphasis on *disposal* of refuse rather than sound management and reuse will prove to be a short-sighted stop-gap. An alternative is suggested in the report of the Colorado Environmental Commission, which recommended a study of potential recycling systems, markets for recycled products, power generation, and the possibility of coupling the whole program with a regional transportation system (5).

Occupational Health

The department is experiencing some difficulties in administering the Occupational Health Act of 1971. Confusion reigns at both state and federal levels as to the scope of the legislation and the appropriate agency or agencies to administer and enforce it. The Industrial Accident Board (Department of Labor and Industry) has been administering the Occupational Safety Act and was designated by the governor as the lead agency for the receipt of funds under the federal Occupational Health and Safety Act. At the same time, the Board of Health and Environmental Sciences is statutorily designated as the implementation authority for the state Occupational Health Act. Herein lies the confusion. Interagency negotiations are being carried out to determine the allocation of administrative authority under both state acts. Implementation of the legislative intent and potential of the state health act is delayed by these jurisdictional problems. The health department has promulgated regulations, as per the authority of the act, which include restrictions on laser energy, occupational noise level, and air contaminants.

One aspect of the occupational program about which the department is very clear is radiological-health. Regardless of federal or Industrial Accident Board activity, the agency will continue its program of radiological surveillance covering pasteurized milk, snow-coring, phosphate-processing plants, radon health mines, private water supplies, mine-tailings, X-ray, and laser equipment.

Air Quality

This subject has received more public attention than any other environmental concern, especially since the implementation plan that the Board of Health and Environmental Sciences proposed to the federal Environmental Protection Agency was blocked by the governor and remains in limbo.

The department has accomplished much under the authority of the state Clean Air Act of 1967. Two new sections dealing with urban air pollution and agricultural and forest burning have been established. Several new control projects are underway, including a program to encourage frequent street cleaning and paving or the use of dust suppressants. A newly hired department meteorologist is helping to coordinate slash-burning activities of many federal and state agencies to insure that any necessary burning is carried out under the most favorable atmospheric conditions. Temperature profile soundings have been completed in three valleys to aid in assessing their dispersion characteristics. The permit system developed under openburning guidelines has resulted in some improvement in air quality, although securing full compliance is difficult. Tepee burners are currently subject to a visual emission standard and are slowly being phased out.

The department has encountered some problems in enforcing the Clean Air Act through county attorneys, who have been reluctant to take violators into court. Hiring of legal counsel at the state level is under consideration. This is only one example of the patchwork or nonexistent enforcement that can result from reliance upon local-level initiative.

Water Quality

As noted in Chapter III, major revision of the state's water quality law was accomplished in the 1971 legislature, and good funding for the program was appropriated. The department's bureau of water quality believes that compliance with existing standards will be nearly complete by the end of 1972 (29). If so, continuing surveillance of municipal and industrial discharges will still be necessary to insure adequate control. The standards themselves may require revision to accomplish that goal. Special attention should also be paid to the nondegradation clauses of the Montana Water Pollution Control Act, especially since the federal government may soon require the best practicable technologies in water pollution abatement.

Several deficiencies in the water quality program still exist. For example, the lack of interdisciplinary staff in the bureau should be remedied and promulgation of feedlot regulations was long overdue. Problems are being encountered in eastern Montana, where recommended federal standards on the health and esthetic aspects of water supplies are not being met. The difficulty is the high concentrations of dissolved solids — sodium carbonates, iron, calcium, and magnesium — found in drinking water. The Department of Natural Resources and Conservation recently completed a study on 10 of the communities involved. The study, together with a series of recommendations, will be presented to the communities in the near future.

Perhaps the major water quality problem continues to be construction of secondary sewage treatment facilities. This program is impeded by local inertia and bonding restrictions, in spite of a recent legislative appropriation of $4 million for the purpose.

The more profoundly crucial questions regarding water quality in the state are outside the jurisdiction of the health department and involve the initial appropriation of water for various uses and the maintenance of a conservation flow in all watercourses. At some point the department should be able to contribute expertise on the matter. These important concerns and the overall state water plan are discussed under the Department of Natural Resources and Conservation.

Noise Pollution

The Board of Health and Environmental Sciences has had occupational noise restrictions in effect for some time. However, the department has no specific authority to regulate what might be called environmental noise. The only recourse for excessive noise levels not directly associated with working conditions is the nuisance law, a civil remedy that does not offer broad coverage. Seeing this void, the department is drafting enabling legislation to set standards and restrict noise levels. The primary application of these standards would be to transient sources such as motor vehicles. In establishing such standards, the department is consulting with noise specialists and is taking measurements of normal background noise levels in various parts of the state. Local units of government could have an important role in a noise pollution abatement program; for example, ordinances could be enacted that would prohibit the modification of any vehicle in a manner that caused it to produce more noise than at the time of manufacture.

Montana now has only one statutory noise standard, that covering snowmobiles. Since noise encountered in back country areas as well as in communities exceeds levels permitted by occupational noise restrictions, more attention to the environmental noise situation is needed.

The Oregon Environmental Quality Report for 1971 notes that in implementation of noise abatement and control,

> **. . . one should not wait until all research is done and all effects of noise are completely understood. Working standards can be implemented on the basis of existing knowledge and then refined, if necessary, when more is known (1).**

Certainly this statement applies to control of noise pollution in Montana.

Subdivision Regulation

The health department, along with other agencies charged with land use authority, is having difficulty regulating subdivisions. The department's authority is restricted to a subdivision's water and sewage facilities, and this authority is further restricted, perhaps stymied, on three counts: jurisdiction is limited to subdivisions up to five acres (the effort was made to cover 10-acre subdivisions), property transferred by metes and bounds rather than by platting is not subject to review, and a "sanitary restriction" clause permits the subdivider to avoid giving the department comprehensive information on water quality conditions and plans. This clause amounts to a loophole that makes it unlikely that the department will get sufficient information for adequate review of water quality problems involved in subdivisions.

Department of Highways

Anyone who has driven from Helena to Boulder during the summer of 1972 knows that the location, construction, and maintenance of highways and related facilities have a substantial impact on environmental quality. A number of environmental questions confront each proposed department project and must by law become a formal part of the decision-making process. The department has noted the increasing nationwide concern over the environmental effects of highway construction and currently has several programs that attempt to ameliorate some of the identified adverse impacts.

Under the Montana Strip Mined Land Reclamation Act, the highway department requires all contractors to submit reclamation plans before initiating borrow pit operations from which 10,000 or more cubic yards of materials will be taken. When construction is completed, the contractor must comply with all provisions of the plan. The acceptability of the completed operation is determined by highway engineers at the field and division levels.

The department is currently conducting a small experiment in revegetation of a segment of its riprap operation on the Clark Fork River. Interstate construction involved extensive river encroachment and channel alteration. By agreement with the Department of Fish and Game, an effort was made to maintain the original length of the stream by constructing two meanders and using large boulders as riprap. The voids in these boulders have been planted with native trees and shrubs from nearby sites, including willow and cottonwood in the silt deposits at the high-water line. This revegetation project, if successful, will improve roadside esthetics and could restore fish habitat in this part of the river. It could also set a good precedent for future projects as well as for the remainder of the Clark Fork project.

Two recreational water areas — Frenchtown Pond and Bearmouth Lake — were created in conjunction with highway projects over the last few years. They provide year-round fishing opportunities adjacent to the interstate system.

The department has developed specifications for slash disposal after right-of-way clearing but does not believe that this is the proper approach. Department personnel feel that the responsibility for emission control in slash disposal should rest primarily with the contractor as regulated by the Department of Health and Environmental Sciences (16). However, the administrator of the health department's environmental sciences division disagrees, maintaining that the Department of Highways should enforce its own regulations (28).

The right-of-way section of the highway department has been involved in other environment-related projects: acquisition of land adjacent to highway projects for recreation or wildlife habitat, an anti-litter campaign, and implementation of the Outdoor Advertising Act (2). The last two programs have not shown visible progress. Judging from the amount of litter still strewn along the rights-of-way of nearly every roadway in the state, the amount spent on litter collection is inadequate. Of course, the root of the litter problem is the person who discards the refuse, and to date no campaigns have been successful, including the nationwide Keep America Beautiful.

Since the department's regulations pursuant to the Outdoor Advertising Act are an almost verbatim rendering of the act, the time required for their drafting and adoption — over a year — seems inordinate. In addition, the act specifies that after 90 days from its effective date (June 24, 1971) no sign can be erected without first obtaining a permit. The Department of Highways extended this permit deadline, without any explicit or implicit statutory authority, until June 30, 1972. Perhaps slow promulgation and delayed enforcement of regulations contributed to the apparent misunderstanding that resulted in the erection of a number of unauthorized signs between Gardiner and Livingston in April of this year.

Other efforts by the department include requiring contractors to control emissions in hot-mix operations, paying for dust reduction in highway projects, and using bituminous surfacing on frontage roads.

No other state agency has more potentially adverse environmental impacts to cope with as a result of its normal operations than the Department of Highways. Location and construction are problems in themselves; attendant activities such as recreation and increased travel, which the department solicits as part of its advertising program, can also have severe impacts. All of these need assessment if the highway program is to encompass environmental quality.

The main shortcoming within the department appears to be lack of a systematic, interdisciplinary assessment of highway policy and practices as they relate to environmental quality. The department does obtain input from other agencies in its decision-making process, but the weight of these views in final decisions is not easily determined. A recent example of this can be seen in the Butte-Boulder I-15 draft environmental impact statement. The Department of Fish and Game was notified that its contribution to the statement might be edited by the highway department. As it turned out, the fish and game contribution was included, but a list of attached questions was not answered and was omitted from the draft impact statement presented to the public.

The highway department should at least be certain that the assessment of various environmental inputs are a matter of record through some formal memo procedures. Even better would be an interdisciplinary team within the department to review the environmental impacts of operations. The Environmental Quality Council, at its June, 1972 meeting, passed a resolution recommending the use of environmental design arts in all future highway projects. To do so would be a healthy response to the thinking of landscape architect Ian McHarg who wrote:

> **A plumber is a most important member of society — our civilization could not endure long without his services: but we do not ask plumbers to design cities or buildings. So too with highways: the engineer is most competent when considering the automobile as a projectile that responds to the laws of dynamics and statics. He understands structures and pavements very well indeed and his services are indispensable. But the matter of the man in the automobile as a creature with senses is outside his ken; the nature of the land as interacting biophysical processes is unknown to him. His competence is not the design of highways, merely of the structures that compose them — but only after they have been designed by persons more knowing of man and the land (13).**

Should it be thought that environmental assessment in highway construction is not a serious matter, the remarks of Omar Bradley are good counsel:

> **Year after year our scenic treasures are being plundered by what we call an advancing civilization. If we are not careful, we shall leave our children a legacy of billion dollar roads leading nowhere except to other congested places like those left behind (3).**

Department of State Lands

This department is headed by the Board of Land Commissioners, created by the 1889 state constitution and made up of the governor, superintendent of public instruction, secretary of state, and attorney general. The overall function of the Department of State Lands is the administration of state lands acquired by grant from the federal government or by other means. The department is involved in two major environment-related operations.

Management of State Lands

As mandated by the state's Enabling Act, school lands must be managed for dollar return to the school fund. Other federal grant-lands must be managed for the purposes for which they were granted, generally the maintenance of a particular state institution. The state constitution provides that all state lands are to be held in trust for the people and for the lands' intended use. Neither provision clarifies the extent to which such lands can be managed for long-term public benefits as well as for short-term monetary returns to the school fund or other institutions. Fortunately, by 1969 legislative enactment, the lands can be managed in trust for the attainment of worthy objects helpful to the wellbeing of the people under the multiple use concept (19). To clear up the basic conflict, the 1967-1968 Interim Committee to Study the Diversified Uses of State Lands (hereafter, the interim committee) recommended an amendment to the state constitution to permit the Board of Land Commissioners to classify land in accord with sound land management practices (6), as did the 1971 legislature.

The board has constitutional authorization to lease lands for various purposes. Most are leased for grazing and provide a portion of school funding. Two conditions of environmental import attend this leasing: grazing permits require compliance with all existing and future environmental quality regulations and extermination of any noxious weeds or "gophers." The extermination requirement can result in serious impacts unless the state develops more environmentally sensitive weed and rodent control programs. Although the board can incorporate more stringent environmental restrictions into new leases, it cannot do so with leases already operative. Also, monitoring the overall lands is difficult and any number of environmental abuses can go substantially unnoticed. The interim committee reports:

> Restraints and conditions (on leases of state lands) are imposed by the legislature and the Land Board through the lease form. These restraints and conditions for the most part are excellent. In general, the conservation requirements imposed on the lessee are good and reflect sound judgment. The fact remains that the lessees, rather than the state, manage the land resource. The level of conservation practices ranges from poor to excellent depending largely upon the lessee's interest and knowledge of sound management practices (6).

It is not clear to what conservation requirements the committee was referring.

To ameliorate the difficulty of divergent management quality, the interim committee recommended establishment of a state land resource development plan. Although no formal response has surfaced on this or the other points raised, something akin to the recommendation is proceeding slowly in the department. An inventory of all state lands has been initiated to describe what the state owns and to identify historical, present, and potential uses. In completing this inventory, and in other efforts to attain quality land management, the department is hampered by a shortage of staff. For example, the lands inventory proceeds at the rate of only 80,000 acres a year because one person does the field survey during the summer months. An additional intern was obtained for the summer of 1972 to study problems of state land use, including methods of compensating the school trust when lands are not used for immediate dollar return.

Shortage of staff also hampers monitoring of environmental impacts on leased lands. This situation, combined with lack of environmental concern and/or information on the part of many land users, dictates a crisis approach in state land management: until a situation deteriorates to the point where it cries for attention it is not subject to correction.

Mining and Mine Reclamation

Under the mining reclamation acts passed by the 1971 legislature, the land board now has authority to require and scrutinize certain reclamation projects. Because both statutes are new, experience with their operation is tentative. In general, the department is pleased with regulation activities to date, although problems have existed with sand and gravel operations, some of which are still begun without a reclamation plan. Nearly all operators are now aware of the law and the department will rely on legal action for compliance in the future (23). The hard rock mining act has been used to regulate dredge mining since the Montana Supreme Court ruled that the 1969 Dredge Mining Regulation and Land Preservation Act was unconstitutional. Although authority under the hard rock act may be adequate to cover dredge mining, a clarifying amendment would be desirable.

The strip mining act has some deficiencies that hamper environmental regulation. The act specifies that reclamation agreements with the Board of Land Commissioners are contracts, unlike the permits under the hard rock mining act, which enable the board to review operations periodically. The signature of the land commissioner on strip-mining contracts removes the department from further scrutiny of mining activities.

The board also has no authority to deny strip mining in areas where there are excessive slopes, scenic or archeologic values, or where for other reasons adequate reclamation is not possible. The law simply orders the board to enter into contracts with applicants, in spite of the fact that areas such as the Bull Mountains and Sarpy Creek may present insurmountable reclamation problems. In addition, the act contains no provision allowing the board to regulate the method of mining in steep or otherwise sensitive areas.

Another difficulty with the act is its silence on the features of an adequate reclamation plan. To aid the board in establishing minimum standards, the act should specify requirements for topsoil reclamation, establishment of stable and diverse vegetation, and maximum allowable slope of spoilbanks.

Realizing the enormity of impending coal/energy developments, the legislature and the land board should look for new regulatory tools to minimize adverse impacts on the land.

Conclusion

All told, the lands owned by the state present a unique opportunity to exemplify quality management. Since the state actually owns the resources, these lands can be more easily managed — or mismanaged — than privately owned land. However, the dual obligation to maintain and enhance resource capacity and environmental amenities while at the same time observing an explicit revenue mandate is clear. Resolution of conflicts inherent in this duality will require more effort than is possible with the present small staff. Additional effort, and thereby staff, will also be needed to meet the responsibilities of administering the mining acts.

Department of Agriculture

Divisions comprising this department will no doubt play an increasingly important role in monitoring an industry whose existence immediately depends on a viable relationship with the ecosystem. The department is involved in a number of activities that affect environmental quality

Perhaps the most noticeable, since the Presidential executive order prohibiting interstate sale of certain chemicals for predator control, is the use of poisons, normally strychnine baits, for rodent control. The Environmental Quality Council has granted an emergency compliance waiver to the department in response to a letter from the governor directing certain agencies to find a source of strychnine baits and to establish a temporary distribution system. The waiver permits the department to proceed with the governor's order without previously filing an environmental impact statement. It is conditioned by stipulations that preparation of the impact statement be started immediately, that it contain explicit justification for chemical rodent control, and that nonchemical alternatives be fully assessed. One of the weaknesses of the rodent control "emergency" is that no rationale has as yet been offered for the chemical control program

The pesticides division apparently does not have sufficient funding to expeditiously implement the new pesticide law, although federal matching funds may be made available under a measure now before Congress. Full implementation — registering all pesticides, licensing applicators and dealers, etc. — will require about two years at current funding and staff levels. In addition, there is no central pesticides laboratory to enable agencies to analyze the problems of pesticides use. Herbicides, as well as rodenticides and insecticides, are commonly used in the state. Although their effects can be subtle and widespread, no studies have been made (8). Quite simply, we don't know what we're doing, environmentally speaking, in the continuing widespread use of various chemicals.

Another practice whose environmental impacts have not been fully assessed is fruit fly extermination, especially in lakeside orchards. The law requires spraying and extermination of the fly, but the effects of any residues on water, air, vegetation, and wildlife have not been analyzed.

The horticulture division inspects produce and has instate quarantine power, but is hampered by the fact that the program is seasonal. Recruiting competent personnel on a seasonal basis with limited funding is difficult and limits inspections. Extensive use of chemical fertilizers to induce growth is one more example of an agricultural program that has been assessed only as to its effect on productivity, not on the environment.

The above are established programs whose impacts require retrospective environmental assessment. For other programs, such as the medicated feed law that may come up in the 1973 legislative session, impacts can be considered beforehand. Medicated feeds, which are currently covered in a limited way by the state Food, Drug, and Cosmetics Act, have immediate environmental consequences. Since similar medications are used for humans, resistant strains may possibly develop through adaptation and make human disease controls ineffective.

The Department of Agriculture will also be involved in regulating land use, including subdivisions. Urban sprawl is already intruding on prime agricultural land. This is best exemplified in the Yellowstone and Gallatin Valleys, where uncontrolled subdivision offers substantial short-term profits to retire land permanently from agricultural use.

All the above agricultural and related activities need review and monitoring to determine their effects on the agricultural and natural environments. Since the two are largely inseparable, the Department of Agriculture will have to assume a prominent role in assessing a broad range of programs and their environmental impacts.

Department of Planning And Economic Development

This department was created by the state's 1967 Planning and Economic Development Act. The act's declaration of necessity and public policy is devoid of express concern with the quality of the natural environment, as are the four departmental functions — state planning and community, recreational, and economic development (21). This omission was noted in a recent survey of land use tools sponsored by the Federation of Rocky Mountain States. In the study, Craig Kirkwood writes of the Planning and Economic Development Act.

> **The policy statement in this law points up the emphasis on economic development in Montana with a correlative lack of official concern with environmental issues of current saliency. And this policy of emphasizing development continues to be stressed throughout the statute (10).**

Kirkwood goes on to note that the agency's development program is probably not as bad as the policy statement indicates; certainly, however, phrases such as "accelerated development of natural resources" portray an attitude far removed from what should be a coeval concern with environmental quality

Since the department is involved in a number of activities not directly related to unrestrained economic growth, it might be wise to alter the policy statement. With increasing awareness that economic growth must be assessed in terms of its environmental impacts, economic development activities are appropriately subjected to Montana's Environmental Policy Act. The department has been involved in two major activities relating to the natural environment:

Assistance to Local Governments

The community development division provides technical planning assistance to cities and counties on request. The main thrust of this involvement during the past year has been to aid in the establishment of county planning boards as authorized by the 1971 legislature. Planning and zoning laws are explained and technical help is provided for the drafting of subdivision regulations. The department has been especially involved in planning in Gallatin Canyon. An interagency and interdisciplinary panel was set up to review this activity and a group of local citizens served as an advisory council.

Recognizing that subdivision will be the course of future land use, the community development division is emphasizing the need for countywide regulations. Model regulations have been drafted, but will need expansion to cover environmental considerations. They now control only the internal design of developments: platting, streets, sanitary and drainage facilities, lot sizes, road configurations, etc. Drafting a model zoning ordinance presents even greater difficulties, since zoning problems vary throughout the state.

The department is preparing amendments to existing planning and zoning statutes, which now constitute a confusing and scattered body of law. Efforts will also be made to develop the outline of a statewide land use authority. All these planning tools become more crucial as developments proliferate, and should be accorded top priority. It is also essential that all involved agencies maintain formal liaison. Better still would be an interagency approach to land use, with regularly scheduled meetings and exhanges. Montana is in the same under-the-gun status as other states in land use problems, and unilateral agency action is dangerous as well as unnecessary.

Clearinghouse Activities

The second general area of departmental activity was officially initiated when the governor assigned the agency to review and distribute federal environmental impact statements. The department maintains a central file to show the history of impact statements as they evolved through initial drafts and agency inputs to the final form in which they are submitted. About 150 such proposals have been reviewed. The projects involved had a total value of about $13 million, and many were attended by significant environmental impacts. The department's activity as clearinghouse for these projects resulted in a number of them incorporating more stringent environmental precautions (12).

Perhaps the department, given its existing liaison with the federal government, will continue to monitor and assess federal EIS's. Most important, however, is not so much the agency through which the statements are channeled but their content. That is, since the statements concern environmental impacts — and are not merely intergovernmental memoranda — any agency reviewing or editing comments into final form should have competent environment-oriented people on the staff.

This is especially true of the Department of Planning and Economic Development, given the fact that it is encouraging entry of new industry, expansion of existing industry and agriculture, new markets, and accelerated development of natural resources. An example of the type of development that can seriously affect environmental quality is the Big Sky recreational real estate complex. This development was the department's number one priority in 1971, taking precedence over revision of state planning laws, assistance to local comprehensive planning, and state planning activities (7). That this and other departmental activities need careful review as to their environmental implications is indicated not only by the controversy over some aspects of the Big Sky project but also by the fact that land use regulation is a high priority unresolved environmental concern.

Department of Natural Resources and Conservation

This department was created by the Executive Reorganization Act of 1971, by which five resource agencies — Water Resources, Conservation Districts (which includes the Grass Conservation Commission and Soil and Water Conservation Committee), Oil and Gas, Forestry, and Centralized Services — were organized under central direction. All of these are now divisions of the Department of Natural Resources and Conservation, all but the last are closely environment-related in title and function, and each has an environmental coordinator on the staff. In the office of the department director, an assistant for environmental and legal affairs assesses environmental matters, including implementation of the state's Environmental Policy Act. Departmental review of environmental statutes, authority, and programs is still at an early stage. However, formal internal procedures for the assessment of environmental impacts have been adopted within each division, whose main environment-related programs are discussed below.

Water Resources

The division consists of two bureaus: engineering and planning. The former, which was previously involved in storage, diversion, and irrigation projects, has no projects in design at this time. Federal activities in the field seem to have outstripped state operations. If the bureau is to engage in future development activities, it should broaden the base of its disciplines, which are now only engineering and hydrology. Biology is a necessary addition to insure that environmental quality considerations accompany the design and development of any further projects.

The planning bureau is involved primarily with the development of a state water plan, as required by the Water Resources Act of 1967 (22). This act also changed the name of the Water Conservation Board to Water Resources and permitted the agency to promulgate regulations to effect the purposes of the act. These purposes, which are now the division's, include the optimum beneficial use of water; no waste of water resources, use of water for maximum social and economic prosperity, protection of water supplies for public recreational uses and for conservation of wildlife and aquatic life, and coordination of water development with that of other resources. With such all-inclusive intent, the power to set regulations is a substantial grant of authority and responsibility and could be used to speak to a number of crucial water questions. However, no regulations have been adopted under the act, an omission rivaled only by the long period of time taken to complete the water plan. Lack of a plan has been costly: along with precluding development of central expertise at the state level, it has resulted in federal preemption of state efforts to determine water priorities. The state water plan now awaits federal input for its completion. Meanwhile, Montana water needs are not vigorously asserted against the claims of federal agencies, and impending water developments are not assessed from the total perspective that only a state plan could provide.

Because the plan is not completed, use of water — as the *base* resource — cannot be integrated with that of other resources. This failure will be especially significant in terms of coal development in the state, since such development puts excessive demands on available water. The consequences of accelerating conversion of water use from seasonal agricultural to year-round industrial have not been examined.

Existing water law has several other deficiencies. For example, Montana is the only one of the 14 western states that does not have a central filing system on water appropriations. (It will have, if the new constitution is implemented.) Also, the state has no legislation on maintaining conservation flow in streams, although a section of the existing Water Resources Act comes very close to requiring it. State water rights law is a mess, many streams having claims well beyond any reasonably expected flow. The Water Law Advisory Council has draft legislation on these and other water problems, which, together with new constitutional provisions on state ownership of water, legislative determination of beneficial uses, and centralized records, should help considerably.

The division also administers the Floodway Management Act, the Weather Modification Act, and the Dam and Dike Safety Law. This last measure involves the inspection of dams and dikes, some of which were built in the 1930's and are in bad shape. County attorneys are relied upon to take action upon determination that an unsafe condition exists.

Conservation Districts

Two bureaus, grass conservation and soil and water conservation, make up this division. The former administers the rangeland resource program, basically an informational, promotional vehicle for improving forage conditions on state rangelands. The program is essentially without regulatory authority but does attempt to educate for good land practices. The bureau also administers the Grass Conservation Act, which sets up cooperative grazing districts throughout the state. This activity mainly involves advice, assistance, and record-keeping. Under the Executive Reorganization Act, the bureau chief, the division administrator, and the department director may supervise the grazing districts subject to the act. The act's stated purpose is the "conservation, protection, and proper utilization of grass, forage, and rangeland resources." Although it was passed initially for economic reasons — railroad lands were being grazed without regulation or income to the railroads — the districts established under it are now involved in environment-related matters, including establishment of carrying capacities for grazing lands. Production progress indicates that lands have improved to the point where they are at 50 percent of potential. Eighty percent is a target figure with the next 10 years (9). Since setting carrying capacities directly translates into permissible resource use, this aspect of the program merits environmental scrutiny.

The soil conservation bureau administers the Conservation Districts Law, which was enacted in 1939 and amended in subsequent legislatures. Under this measure districts can be created and, after following a defined procedure, can formulate land use regulations for conservation of soil and water resources and prevention and control of erosion. Since erosion, generally the result of land use in excess of capacity, is the leading source of nonpoint pollution, this authority could be vital. However, none of the existing districts has followed the petition, hearing, and voting process required to promulgate land use regulations. These districts cover 97 percent of Montana (26). The fact that 55 percent of districted land needs treatment to reduce soil loss suggests the importance of adopting some form of regulation. The voluntary nature of the program will obviously need to be supplemented by mandatory land use restrictions.

The districts' major projects are physical developments, some of which have significant environmental impacts. These include riprap on stream banks, sagebrush control, construction for water storage or diversion, etc. The bureau has a memorandum of understanding with each district concerning any diversion that might come under the Stream Preservation Act. In addition, copies of the Environmental Policy Act have been mailed with the agency handbook to facilitate compliance with EIS requirements.

Providing technical aid to all who request it — on feedlots, land reclamation, and a host of other problems — is impossible for the bureau. The assistance of other agencies, primarily the Soil Conservation Service and the Departments of Health and Environmental Sciences and Fish and Game, is usually obtained.

Conservation districts provide a healthy decentralization in the determination of resource uses. However, districts should be monitored to insure that local activities do not violate minimum environmental quality considerations. This will be especially true when the state water plan is completed, at which time districts will be subject to whatever limitations are contained in that plan.

Oil and Gas

This division administers laws and regulations to prohibit oil and gas wastage and promote efficiency in drilling, operating, and storing. Functions include permitting and bonding operations, insuring that drilling is done within the company outlines of intention, approving changes in drilling and testing, insuring that wells are plugged, etc. Since the quality of an operation varies with the skill of the operator, compliance with regulations must be checked, not assumed. One example of a wasteful practice now discouraged is the flaring of quantities of gas that previously appeared too small to recover.

Checking a sizeable number of spill and leakage complaints is apparently one of the division's main activities. In some cases, more accurate identification of spill locations would facilitate prompt assessment and cleanup

The division has been informed of its responsibilities under the Environmental Policy Act and intends to file environmental impact assessments, especially in cases involving possible contamination of surface water or pumping of freshwater into wells in flooding operations.

Forestry

The division manages state forestlands (including fire prevention and suppression and insect control) and provides technical assistance and advice to private woodland owners and processors of forest products. Management of state forestlands involves timber sales, stand improvement (thinning, planting, and slash disposal), road construction, powerline easements, and land exchanges. Most slash is burned, and to reduce smoke loading of valley air masses, burning is coordinated with meteorological data from the health department and the Forest Service.

State forestland management exhibits the duality of goals found in all state land management efforts. The 1971 annual report of the state forester's office — now the division of forestry — reflects the difficulty:

> **The goals of the Forest Management are to . . . provide sustained maximum income for the schools and other trust funds, attainable under the land management plan prepared within the scope of the Multiple Use Concept (25).**

The demands of income maximization can reduce the quality of a resource by encouraging a clientele with a persistent monetary interest in the resource and by restricting the amount of land available for watershed protection, wildlife habitat, recreation, and other uses that do not yield immediate economic benefits. As implied previously, paramount concern with the maintenance of resource quality is the only environmentally sound approach and thereby the only sound economic approach.

The forestry division grants leases on a substantial number of cabin sites, maintains some small recreation areas, and, as noted earlier, conducts land exchanges. Land exchanges have become the subject of sharp controversy. They are important for environmental quality considerations, especially if continued or if the recommendation of the Interim Committee on the Study of the Diversified Uses of State Lands is implemented. In this recommendation, the committee noted the widely scattered character of state land tracts and urged that the state forester and the land commissioner initiate a long-range plan to consolidate state-owned lands (6). Statutory and constitutional limitations will have to be observed in such exchanges. The state must obtain land of equal or greater value and of approximately equal area (20). These and a number of other difficulties that hamper an expeditious program of consolidation will need agency and public review as efforts to collect state lands into manageable units proceed.

In recent years, environmental concern has been directed toward the automatic practice of controlling all forest fires. The fact that fire has played an important role in ecosystem development over millennia, and that fires are environmentally beneficial in the creation of elk browse and other wildlife habitat, indicates that some should be allowed to burn. Use of controlled burns for habitat creation is still in its infancy. Meanwhile, areas exist where high suppression costs coincide with the need for fire management. The statutes on fire prevention and suppression do not take notice of these situations. Although no free fire zones are currently delineated, amending the statutes to permit agencies to manage fire from an environmental perspective should be considered.

Currently the state does not initiate or participate in chemical spray programs for insect control federal bans have brought the state program, in which DDT was once used, to a halt. The Forest Service is now experimenting with certain other insecticides. Whatever program is designed to deal with the pine bark beetle, larch casebearer, and spruce budworm problems will involve significant environmental impacts and require full environmental assessment.

Department of Fish and Game

The department is headed by a five-member commission appointed by the governor. Within the department are divisions of environment and information, fisheries, game management, parks and recreation, and law enforcement. All divisions have significant environmental involvements and coordinate their operations to insure the quality of fish and wilflife habitat.

Environment and Information

One of this division's most effective environmental instruments is the Stream Preservation Act (18). As described in Chapter III, this statute outlines the state policy to preserve natural stream conditions except where ". . . necessary or appropriate after due consideration of all factors involved." The act requires state agencies to notify fish and game of any proposed alteration, provides for departmental notification to the applicant of any adverse habitat impacts, requires that such notification be accompanied by recommendations or alternative plans to eliminate or diminish the effect, and establishes arbitration procedures when a controversy between the department and the applicant cannot be resolved.

When vigorously applied, the act is a powerful tool in negotiations with state agencies such as the Department of Highways. However, it has two weaknesses that result from its incomplete coverage. First, irrigation projects are specifically exempted. The rationale behind this exclusion is not clear. Documented instances of improper headgate location and diversion methods indicate that requirements of the act would be beneficial to both the irrigation project and the stream involved. Another shortcoming is the fact that private individuals are generally excluded from the act.

Since private sector problems are encountered (for example, on the Little Blackfoot), the alternative suggested by Idaho's Stream Channel Protection Act, in which all alterations are covered, should be reconsidered.

An environmental insult is clearly an insult, whether inflicted by an agency or an individual, a highway or an irrigation project. If the objective of the Stream Preservation Act is to protect all the state's fishing waters against degradation, then private operations should be subject to the same restrictions as public projects. Three other areas in which the department is given a role in mitigating public agency adverse impacts but not those of private owners are logging, spraying, and general land development.

The environment and information division represents fish and wildlife interests on a number of interagency review boards, including that for pesticide regulation. This regulatory group assesses the rodent control program. One of the difficulties in such assessment is the common assumption that extermination is the only acceptable solution. Little is known about the rodents involved, their habits or biology, and apparently little work has been done on finding an acceptable population level (17).

Sitting on the advisory board for water quality, the department, frequently via this division, provides the water quality program with the interdisciplinary expertise it sorely lacks. A biologist working for fish and game complements the primarily engineering background of the health department's water quality division. Environment and information is also represented on the advisory board that works with the Department of State Lands to insure that suitable habitat is left after mining activities are completed.

The division is conducting a series of studies in the Stillwater district, the Bull Mountains, the Smith River drainage, and near Lincoln. The point of the studies is to give land managers specific environmental information to guide decisions on land and water use. Efforts are made to obtain industry sponsorship of some of the projects.

To insure that interagency and intra-agency action can be reviewed, the division keeps a central file on all inputs into the fish and game department's environmental impact statements.

Fisheries

Preservation of aquatic habitat is the primary function of this division. Toward this end it works with various agencies — the Soil Conservation Service and the Forest Service, for example — to insure that existing habitat is maintained or, where possible, improved. This function takes on added importance with accelerating human encroachment on sometimes fragile ecological communities.

Another part of the fisheries program also relates to encroachment: providing public access to fishing waters has gradually evolved into establishment of improved water-based recreation sites. The division's involvement in this program is generally confined to listing areas to which access is desirable. The development that follows (under the direction of the recreation and parks division) can have a serious impact on environmental amenities. For example, the Turah campground, just off Interstate 90, has become a carnival type of crowded recreation site. The same is true of Park Lake near Helena, where an improved road and the attendant accessibility have overcrowded the area. These are only two cases in which overdeveloped access has destroyed the quality of outdoor recreation. With increasing recreational pressures on certain areas, some form of access limitation may be required.

The division manipulates fish populations to provide more of certain species of game fish. Such tampering with natural populations requires extreme caution. It is interesting that this ambiguous activity can also be used to regulate the intensity of recreation use. Diverting fish planting from overused developed areas — say Canyon Ferry Reservoir — could relieve pressure. This practice can have a more direct effect in reducing damage to essentially wild areas such as Baldy Lakes in the Big Belt Mountains. Whether any species should be introduced into wilderness waters is questionalbe.

What is called the "rehabilitation program," another facet of population manipulation, should also have careful monitoring. Basically, this entails chemical eradication of certain fish species and restocking with a species held to be more desirable. Although the chemicals used apparently do not affect nonaquatic wildlife, they can affect aquatic invertebrates as well as the vertebrate targets.

The division prepares fishing regulations designed primarily to insure more equitable distribution of game fish. Some are also for the protection of vulnerable species such as the white sturgeon and the west-slope cutthroat. Indirect protection for other species is afforded, given the fact that over-avid fishermen could seriously deplete a population. Decisions that set these regulations are subject to justification through the environmental impact statement process.

The program of planting catchables — which has no positive relationship to the ecological concerns of resource management — has become extremely controversial. A recent department study indicates that planting fish in streams on a put-and-take basis may adversely affect native populations (27). The study shows that the Madison River native fish population **increased** after stocking was stopped and that the O'Dell Creek population **decreased** after stocking was begun. This study will be scrutinized by a spectrum of resource professionals and could be the base for department recommendations on the future of the program.

A small part of the division's function is regulation of commercial fishing. One of the major centers of this activity, Fort Peck Reservoir, is currently under study. As is the case with an increasing number of overworked resources, it may become necessary to limit commercial fishing in this area.

Game Management

The primary goal of this division is expressed by Aldo Leopold in his 1932 work, *Game Management*. "Game management is the art of making land produce sustained annual crops of wild game for recreational use." In this pursuit, it is only proper that the program be bound by the more general environmental quality considerations found in the writings of Leopold and others.

The division attempts to preserve and manage the wildlife resource and its habitat both for their intrinsic ecological worth and for a variety of uses. Other objectives are to maintain a maximum breeding stock of game species, to acquire key areas of wildlife habitat, to inventory wildlife resources and habitat, and to conduct studies and research for scientific game management information.

The trend in field surveys and investigations is increasingly to study not only the status and trend of game populations but also their ecological relationships, an approach that can be seen in the recent division publication, *Game Management in Montana* (14). In addition to studies of big game, game bird, and fur-bearing animals, this admirable compilation includes some interesting chapters on the history and theory of game management. Further exposition of game management philosophy and its specific applications is desirable as decisions are made affecting wildlife, habitat, and other environmental amenities. In-depth discussion of the environmental impact of game regulations is available in EIS's on this year's hunting seasons.

Recreation and Parks

The chief function of this division is to conserve the scenic, historic, archeologic, scientific, and recreational resources of the state in accordance with its historic preservation and outdoor recreation plans. The historic plan involves survey, restoration, and preservation of historic sites throughout Montana. The recreation plan contains an inventory of existing resources and guidelines for recreation programs, site acquisition, and development. With establishment of the two plans, the state became eligible for federal funds under the National Historic Preservation Act and the Land and Water Conservation Fund.

Because the division's preservation and recreation activities are being carried out in a state that still retains many environmental amenities, immediate and future impacts must be fully considered. This is especially important in site development, for concentration of recreational use can often degrade environmental quality. The problem of littering is only the most obvious and least complicated example. More profound are the crucial conflicts exemplified by overuse in the national parks. The realities of carrying capacity apply to human recreation as clearly as they do to livestock grazing or wildlife habitat.

It is critical, therefore, that the agency charged with recreation site acquisition and development have competent, ecologically trained people on the staff. The absence of an environmental design specialist in the recreation and parks division makes it imperative that such expertise be employed, at least in a consultant capacity.

Because of the shrinking number of available sites and rising acquisition costs, the Fish and Game Commission has directed the division to concentrate on acquisition of potential sites rather than development of those already acquired (30). This is a healthy step, enabling the state recreation system to have sufficient land for a quality program. The same policy also mitigates the tendency to overdevelop. A helpful addition would be interim contingency plans for the protection of undeveloped sites.

Law Enforcement

Law enforcement is an important part of wildlife management, and the duties of this division have obvious environmental implications. While most game management laws are concerned in the main with raising revenue and sharing a game harvest, they are often directly related to the health and welfare of wild animal species. This is especially true in the case of illegal kills, which may have a more significant impact than was once thought. Rare species such as prairie and peregrine falcons and grizzly bear may be seriously affected, as well as mountain lion and other important predators (11).

The division enforces various environment-related laws outside the immediate realm of wildlife management. For example, enforcement of the new litter law involves it in regulating an environmentally disgusting practice. Also, the division is developing regulations to control the use of motorboats on certain state waters. Such regulations could eventually prohibit the use of motor-propelled and jet boats in areas where excessive noise can damage habitat or destroy tranquility.

Another important function of the division is to report environmentally abusive practices observed in the field. This is an inexpensive and effective supplement to the surveillance activities of a number of state agencies. Consideration might be given to formalizing this function through additional environmental training.

Conclusion

Many agencies of state government, including counties and other subdivisions, are involved in decisions directly affecting environmental quality. For years, only a very few have given attention to sustained resource quality and environmental amenities. Now, however, increased public concern and adoption of the Environmental Policy Act are beginning to bring the natural environment into partnership with other considerations. New procedures for formalized and reviewable assessment of the environmental impacts of policies and actions are being established and, equally important, more agency programs are reflecting an environmental ethic with the addition of ecologically trained personnel to their staffs.

Nearly every writer on modern bureaucracies has noted that they possess a host of characteristics that need to be tempered. Duplication of effort, the masking of genuine public issues with obtuse bureaucratic language, and the tendency to stand pat with a solidified perspective are on the list. Perhaps the best antidote to these endemic strains is to subject the daily administration of public affairs to public scrutiny through appropriate procedures. One of these will be the continuing review of agency programs and activities by the Environmental Quality Council.

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Staff Investigations

Coal Development Potential in Eastern Montana

Contributed by
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Reasons for Renewed Interest

Montana's coal reserves are again becoming economically important after 15 years of relative inactivity. The primary reasons for the recent renewed interest are the vast quantities available as well as the chemical properties of the coal. It is low in sulfur, sodium, and ash and is nonagglomerating and chemically reactive. Also of significance is the intimate relationship between coal and water supplies, the low cost of shipping through unit trains, increased demand for electricity, and recent advances in coal hydrogenation (7).

In the eastern portion of Montana underlain by coal, a combination of angular sandstone-capped buttes, deeply dissected badlands, rolling hills, and dry climate has resulted in a population density of about one person per square mile and an economy based primarily on livestock. The area contains little industry, few towns of more than 2,500 people, and a limited amount of dry and irrigated farming where the terrain permits, but a great majority of the land is devoted to livestock grazing.

Geology and Reserves

The coal basin, which consists of parts of four states and Saskatchewan, is known as the Fort Union area, named after the formation in which the coal is found. It is Paleocene in age and consists of sandstones, siltstones, claystones, and numerous coal beds in an interlayered sequence. The coal-bearing portion of the Fort Union Formation is primarily of fluvial origin, containing sediments derived from the Rocky Mountains to the west. The terrain on which these sediments were deposited was a low floodplain that contained large subsiding swampy areas and was crossed by numerous meandering streams.

The Fort Union area is perhaps the largest coal basin in the world, containing 40 percent of the United States reserves. Total reserves have been estimated to be 1.3 trillion tons (11), with strippable reserves in Montana calculated to be more than 30 billion tons (8).

Strippable coal is defined as a seam having a minimum thickness of six feet and overlain by 150 feet or less of overburden. It must be relatively free of shale partings and of sufficient areal extent to allow economic production (3).

Water Availability

Water controls all activity in this semiarid region, and the industrial future of the Fort Union coal fields is no exception, because coal-based development requires enormous quantities of water for cooling and conversion. Because most of the coal fields are far removed from existing surface water sources, the nature and extent of development would depend on the quantity of water made available at the mine site. A large volume of easily accessible water would allow extensive generating and conversion complexes. If this supply is not provided through several new storage facilities and an intricate system of government pipelines, development would be more restricted and probably concentrated on mining and export of coal.

The future use of groundwater in coal field development has not yet been firmly established. Evidently very little deep exploratory drilling for water has been done, although the Montana Power Company has drilled to a depth of about 9,300 feet into Mississippian sediments near Colstrip. The chemical suitability of the water varies, but the deliverability of the well looks favorable. It taps three aquifers and flows at a rate of 60 gallons per minute (9). However, the Montana Bureau of Mines indicates that groundwater resources are not adequate to facilitate large-volume industrial development (7).

Surface water sources in the Montana Fort Union areas are the Missouri, Yellowstone, Powder, Tongue, Bighorn, and Little Bighorn Rivers. Industrial utilization requires flow control on the streams from which installations draw their supply. This control is obtained through the use of dams and offstream storage reservoirs. Storage facilities in the general area include Bighorn Lake, Tongue River Reservoir, Fort Peck Reservoir, and the proposed Moorhead Reservoir on the Powder River. The Bureau of Reclamation is also considering Allenspur Dam on the Yellowstone River and two offstream reservoirs on the north side of the river between Forsyth and Billings. A summary of available and potential industrial water from each source is as follows (17):

	Acre-feet	
	Available	Potential
Bighorn River		
Bighorn Lake	262,000	
Powder River		
Moorhead Reservoir		57,000
Tongue River		
Tongue River Reservoir		60,000
Yellowstone River		
Mainstem (with regulation by offstream reservoirs or Allenspur)		1,356,000
Missouri River (15)		
Fort Peck Reservoir	1,000,000 (approximately)	

The Bureau of Reclamation has proposed an aqueduct system for the purpose of providing water for coal development. The agency investigated several routes and delivery points with the primary Montana termini in the areas of Colstrip, Sarpy Creek, Sweeney Creek, Crooked Creek, and Pumpkin Creek. In response to an inquiry, some of the potential users exhibited a definite interest and indicated that total aqueduct capacity should be about 2.6 million acre-feet per year (9). The earliest requested delivery date was 1977, with the majority of the firms listing 1980 as the target date for completion of the system (6).

A significant quantity of water is present on Indian lands in Montana. To how much of this the Indians would be entitled is still undetermined, although it is expected that they would be first in line. The Indians' share would provide a marketable product for the tribes involved, but the anticipated legal battle would have to be settled prior to construction of the aqueduct.

A shortage of water is developing in eastern Montana, especially in the Yellowstone River drainage. The Bureau of Reclamation (16) indicates that 871,000 to 1,004,000 acre-feet of water per year from Montana's portion of the Yellowstone, Bighorn, Powder, and Tongue Rivers are presently under option by energy companies. The agency has also received requests or indications of interest in another 945,000 acre-feet from these streams (17). The appraisal report on Montana-Wyoming aqueducts indicates that the state's total existing and potential supply of water from these sources amounts to 1,735,000 acre-feet per year. Fort Peck Reservoir on the Missouri River has about one million acre-feet of available water that will probably be used as a source for any installations north of the Yellowstone. Additional storage development on the Missouri, such as the proposed High Cow Creek Dam, could expand the supply of industrial water.

In general, it seems safe to assume that a supply of water sufficient to accommodate the coal developments currently under consideration would require complete development of the area's water resources. This would not only mean more dams, but interbasin and interstate transportation of water through the network of pipelines proposed by the Bureau of Reclamation. Before construction begins, the benefit derived from such action should be carefully weighed against other possible uses of the water as well as cumulative primary and secondary environmental impacts. In this area of vast strippable coal deposits, water is the key, whether for production of synthetic crude oil, synthetic pipeline gas, byproduct chemicals, or electric power generation. Provision of a readily available water supply would have far-reaching effects — environmentally, socially, and economically.

Recent Developments

Coal companies now operating strip mines in Montana include the following:

> Western Energy at Colstrip began production in 1968 at a rate of half a million tons per year. The operation has expanded to an estimated five million tons in 1971 (11). A

recent announcement indicates that the company intends to provide a Wisconsin power firm with 2.3 million tons per year.

Peabody Coal Company opened a mine seven miles south of Colstrip in 1968. The company plans to supply Minnesota Power and Light with two million tons of Rosebud coal annually.

Decker Coal Company is expected to mine about 3.4 million tons in 1972 near the community of Decker in southeastern Big Horn County (11). A railroad spur linking Decker with northern Wyoming has recently been completed. Shipping costs are reduced through use of a unit train on which coal is the only commodity transported. The rate per ton varies with the quantity of coal to be delivered and the distance to destination.

Knife River Coal is operating in the eastern part of the state near Savage. The company produces about 320,000 tons of coal per year and disturbs 20 additional acres of land per year (10).

Consolidation Coal Company has a pit in the Bull Mountains from which it removed 39,000 tons for a test burn in 1971.

The next mining operations are likely to be (11) Peabody Coal on the Northern Cheyenne Indian Reservation, Consolidation Coal in the Bull Mountains, and Westmoreland Resources on Sarpy Creek.

Montana's coal basin has undergone intense leasing activity. Many companies and private individuals have taken leases on state land, with Consolidation Coal, Ayrshire Coal, Fred Woodson, and Peter Kiewit & Sons heading the list. The Montana office of the Bureau of Land Management has issued 37 leases embracing 52,588 acres. Seventeen of these leases are in Montana. Production has begun on only 12 of the total, amounting to approximately 1.5 million tons in 1971. In addition to these leases, there are 14 valid prospect permits embracing 37,544 acres.

The BLM also had under consideration 119 applications for prospect permits by 20 applicants, affecting 419,684 acres. The bureau denied these applications, stating, ". . . there is no compelling need, at this time, to encourage further prospecting for a resource when there is already a known supply under lease that is waiting to be developed" (21).

About 16,000 acres of Indian land have also been leased. Two costs are involved here, a lease fee and a development cost similar to the improvement requirement on a locatable mineral claim. After a certain number of years, following review by the U. S. Department of Interior and the Bureau of Indian Affairs, a lease can be canceled if mining operations have not begun. The grace period is usually about 10 years.

Coal-fired steam generation plants presently operating in the state are located in Billings and Sidney. Montana Power has begun construction of a 700-megawatt minemouth plant at Colstrip, the first 350-megawatt unit of which is scheduled to be completed in 1975 (2). Two additional 700-megawatt units have been proposed for the Colstrip site.

What Does the Future Hold If We Have . . .

Strip Mining and Export?

The Montana Bureau of Mines and Geology indicates that 1973 coal production in this state will be about 16 million tons and that it will be expanded to more than 20 million tons annually by 1975 (8, 11). The increasing demand for low-sulfur coal could accelerate strip-mining activity and lead to significantly higher production figures in the near future.

With proliferation of strip mining comes the problem of large-scale reclamation. Extraction of 16 million tons of coal per year from the present mines will overturn 275 to 520 acres of land per year, while full employment of Montana's strippable reserves would disturb a total of about 770,000 acres (20). Although eastern Montana does not have problems with such things as acid drainage, reclamation efforts are complicated by the semiarid conditions of the region. The scarcity of water makes regrowth of any type of vegetation a very slow process. Previous experience shows that unconsolidated spoils left at the angle of repose will not support an effective vegetative cover and that simply leveling the tops of the spoils will do little to alleviate the problem, however, stockpiling soil, contouring spoils, and subsequent use of farm equipment for soil conditioning and seeding offer some possibilities.

In areas such as Decker, in which the coal bed is an aquifer, mining will have a definite impact on groundwater supply, movement, and rate of recharge. A well near the test pit at Decker lost five feet of head after excavation, and evidence indicates that all water will eventually be drained from the coal bed aquifer. Wells will have to be deepened to tap other aquifers as mining progresses. Because spoils have lower permeability than the coal bed, cessation of mining and filling the final cut will restrict groundwater movement and raise the water table upgradient from the mine site. After reclamation, the mined area might serve as a zone of local recharge.

Assuming that reclamation is effective, there would still be a considerable delay before land could be returned to its original use. Until the vegetative cover is firmly established, grazing would be impossible. Wildlife would be displaced for an unknown period, with no assurance that the subsequent habitat created on the spoils would satisfy all the needs of native species.

Strip mining and export would cause other environmental problems. Among these are a dust problem, at least temporarily, in the mining area and vicinity and additional railroad corridors if the coal is shipped by unit train. If coal slurry pipelines are used, large quantities of Montana water will be exported, causing possible local depletion.

Because of the high degree of mechanization in the mining and transportation processes, development for export would probably cause only a small increase in job opportunities and no significant change in the area's overall employment patterns.

Mine-mouth Generating Plants?

The requirements for a mine-mouth generating installation are proximity to fuel source, market, or both, access to large supplies of cooling water, freedom from floods or other predictable natural disasters, and a large tract of land available at a moderate cost. Eastern Montana meets all the requirements except market, and the development of extra-high-voltage grids would provide that.

The North Central Power Study (12) estimates a steam-fired generating capacity of 53,000 megawatts in the Gillette-Colstrip oval by 1980. The complex would provide electricity within a 13-state area and for users as far away as St. Louis, Missouri. Something less than half of the capacity would probably be generated in Montana, which contains 21 of the 42 potential sites. The plants range in size from 1,000 to 10,000 megawatts (the Corette plant in Billings is 180 megawatts), with total estimated coal consumption in excess of 200 million tons per year. About 300-500 full-time employees would be required to operate the Montana plants. These would be in addition to personnel needed for maintenance and service of transmission lines and operation of the mines.

Full development of all 21 North Central Power Study sites in eastern Montana would result in an instate steam-generating capacity of about 69,000 megawatts. Most of the Montana plants would be in the 1,000- and 5,000-megawatt categories, while a large percentage of the Wyoming installations would have 10,000-megawatt outputs.

One of the serious problems associated with the plants is that of airborne contaminants. Even with the most advanced pollution control equipment, enormous amounts of pollutants would be introduced into the atmosphere as a result of the vast quantity of coal used. Electrostatic precipitators and wet scrubbers can remove 99-plus percent by weight of the particulate matter but a much smaller percentage of fine material (less than one micron in diameter). Unfortunately, it is the fines that stay suspended longest, enter most easily and deeply into the lungs, and inhibit visibility. Suspended particles also reflect solar radiation and may seed storms and otherwise alter downwind weather patterns (14). A current example of the problem is the 2,075-megawatt Four Corners plant at Farmington, New Mexico, which in early 1971 emitted over 465 tons of particulates each day and whose plume of pollution could be traced back to the plant from a distance of 140 miles (19). The magnitude of the future problem can be foreseen when it is realized that several of the North Central Power Study plants proposed for Montana are two and a half to five times as large as the Farmington operation.

Much conflict exists concerning the effects of sulfur dioxide, a major emission from coal-burning operations. Evidence indicates that exposure to SO_2 has a retardation effect on plant growth and can be a threat to human health. Of sulfur dioxide in the air, President Nixon's February 1971 message to Congress states:

> **Sulfur oxides are among the most damaging air pollutants. High levels of sulfur oxides have been linked to increased incidence of such diseases as bronchitis and lung cancer. In terms of human health, vegetation, and property, sulfur oxide emissions cost society billions annually.**

Although we have not been able to locate any extensive studies concerning the effects of SO_2 on range vegetation, reports of deteriorated flora make it clear that injury can occur in areas of low annual concentrations when the sources of pollution and/or meteorological conditions are such that the threshold for injury is exceeded. Evidence also indicates chronic injury where concentrations never exceed 0.1 parts per million (18). One investigator, experimenting with the effect of SO_2 on rye grass, reported that yields grown in unfiltered air were significantly lower than similar plants grown in filtered air, with no visible symptoms in the plants. Sulfur dioxide levels ranged from 0.01 ppm to 0.06 ppm, with exposure periods ranging from 46 to 81 days (18).

At concentrations of about 0.05 ppm to 0.25 ppm, sulfur dioxide may react synergistically with ozone or nitrogen dioxide in short-term exposures to produce moderate to severe injury to sensitive plants. The damage caused by the combination of SO_2 and ozone or SO_2 and NO_2 is much more severe than would be a similar concentration of SO_2 and NO_2 individually (18).

These mine-mouth installations would also release large amounts of carbon dioxide as well as varying amounts of uranium, radium, thorium, mercury, cadmium, other heavy metals, and trace elements.

Direct emissions are not the only serious environmental problems created by mine-mouth plants. Blowdown water (water that has been used in cleaning the cooling mechanism) is highly charged with minerals that are capable of killing aquatic life and surface vegetation. These minerals can also contaminate groundwater if leaching occurs. Spoilbanks are yet another source of dissolved solids if water in excess of the normal precipitation (10-15 inches) is applied. Fly ash, removed by the pollution control equipment and disposed in the spoils, contains a number of heavy metals and trace elements, including lead, zinc, copper, sulfur, and boron. These elements, toxic at certain levels, are evidently not inert when buried and exposed to water.

Transmission lines associated with mine-mouth plants are a major esthetic intrusion on the landscape. Corridors, excavations, and access roads as well as the towers themselves cause not only visual but ecological degradation. Pipelines for water supply have similar though less severe impacts.

Conversion Plants and Multiproduct Complexes?

A multiproduct complex consists of one integrated operation to produce electricity, liquid and gaseous fuels, and petrochemicals. These plants would have a capacity of 1,000 megawatts of power generation, 50,000 to 100,000 barrels of liquid fuel per day, and 250 million cubic feet of gas per day. Each plant would consist of a carbonization section producing gas and liquid fuels and a hydrogenation unit producing synthetic crude oil. Char, a byproduct of the carbonization process, is usable as a fuel in the power plant. A three-plant complex would require 50,000 to 75,000 acre-feet of water annually and 12.5 million to 18 million tons of coal (15). The tremendous water and coal requirements would probably limit the number of complexes in Montana to 12 or less (16).

Gasification would probably be the first type of coal conversion in Montana. A synthetic pipeline gas would have to be approximately the same quality as natural gas, meaning a heating value of 950-plus BTU's per cubic foot (13). Sixty-five gasification processes presently exist (15), but none can yet produce at a price competitive with natural gas. The German Lurgi process probably offers the most promise for commercial gasification because fewer steps are needed. It requires larger capital investments than other techniques but has been proven in more than 30 plants around the world, none in the United States.

Lurgi gasification plants may consist of four units (trains) having a total capacity of one billion cubic feet per day and requiring a total investment of about $1 billion. The trains would be located seven to 10 miles apart and each would consume about seven million tons of subbituminous coal as well as 17,000 acre-feet of water per year. This method makes more efficient use of the coal's original energy content than do steam electric installations. Steam generators transform 30 to 40 percent of the coal's heat into electricity, while the Lurgi coal-to-gas process has a 69-percent conversion factor (efficiency). Preliminary estimates indicate that Lurgi gas plants could be operable in the Fort Union area within the next decade.

Several companies have expressed interest in constructing one or more gasification units of 250 million cubic feet per day in Montana, but the intended gasification techniques have not yet been made public. In December of 1971 the HFC Oil Company of Casper, Wyoming requested 50,000 acre-feet of water from the Missouri River for future use in two or more gasification plants near Bloomfield in Dawson County. One may be constructed as early as 1974. Colorado Interstate Gas Company is slated to build a similar plant near Hardin, Montana. A proposed gasification plant near Sarpy Creek on the Crow Indian Reservation is expected to be operational by 1984 (16). Coal requirements would probably remain about the same regardless of the process used, but water requirements could vary significantly. Some estimates of the water needs for a plant capacity of 250 million cubic feet per day go as high as 33,000 acre-feet per year.

Several coal liquefaction processes have been devised and are in various stages of development, but as yet are noncompetitive with petroleum products. These plants would have to produce approximately 100,000 barrels of liquid fuel per day and would consume annually 11 to 15 million tons of coal and 65,000 acre-feet of water (4, 15). No liquefaction plants are currently known to be planned for Montana.

The total instate population increase resulting from coal development might be 300 thousand to 400 thousand people (1, 5). One multiproduct complex would employ more than 3,000 people and might create a city as large as 24,000, which is much larger than any present Montana city east of Billings (17).

The primary environmental problems created by multiproduct complexes would be the same as those previously mentioned.

Impact on the Human Environment

The human environment is made up of numerous systems including industrial, agricultural, residential, commercial, educational, recreational, and political, as well as systems of cultural amenities, communications, and transportation (5). All these systems are interrelated and any change within one is reflected by corresponding secondary changes in the others. It is therefore apparent that intensive large-scale development in a predominantly agricultural region would have far-reaching secondary repercussions.

The transition from an agrarian to an urban-industrial life style could be very rapid in some locations. In these areas the basic employment patterns would be changed, the traditional culture values disrupted, and existing land use relationships altered. Well-planned coal development could perhaps benefit some eastern Montana communities whose populations have declined rapidly in recent years, but such benefits might be short-range.

Industrialization creates an increased tax base at all levels. More income and more property are available for taxation, but the population increase also creates a greater demand and requires greater expenditures for all government services, including police and fire protection, sewage and solid waste disposal, and water. It also requires a larger number of educational facilities, an expanded political system, and a rethinking and modification of the entire transportation system. It means a greatly increased load on all existing recreation facilities and a demand for more.

The increased tax base is often temporary in the case of coal mining and coal-related industry. Unless reclamation is unusually successful and the land is restored to a productive condition, strip mining destroys the base when the coal is depleted and the power companies move their plants closer to new fuel supplies, spoilbanks have little tax value. The present standard of living in the Appalachian coal fields demonstrates the long-range economic impact of indiscriminate mining. The coal and power companies have departed, leaving the people with no jobs and the government with nothing to tax. With exhaustion of Montana's coal reserves, a similar situation would almost certainly develop. The lifetime of proposed generating facilities for Montana coal development is estimated to be about 30 years.

The coal development area of the state may also be faced with the stress and frustration of urban living along with other related problems such as an increased crime rate, poverty, overcrowding, noise, congestion, litter, and neighborhood deterioration.

What Must Be Done?

The question of current versus future use must be carefully considered. Responsible development should include retaining mineable deposits as reserves. A state agency, possibly the Department of Lands, should be given the power of denial to restrict mining in areas such as the Bull Mountains and the Ashland district of the Custer National Forest. Any kind of mining would be very destructive in these heavily wooded hills, but the topography and relief are such that the coal seam is exposed on the valley walls, thus requiring the most ruinous of all open cut techniques, contour stripping. Omission of these areas and others from the present coal development picture would preserve an energy source usuable in the event of a severe future shortage. And if coal, as indicated by many, is only an interim solution to our energy problems, these productive scenic and historic areas might never have to be mined.

The present steam electric generators have half the efficiency of some other generation and conversion techniques, such as magnetohydrodynamics (MHD), now under study. Rapid development of these latter methods could render the present type of facilities obsolete in a short time. The long-range interests of Montana might best be served by delaying coal development for a number of years rather than irretrievably committing the state's resources to an inefficient, outdated technology.

Long-term social and environmental degradation can be avoided only through a coordinated effort by all levels of government, the involved companies, and an interested public to formulate regional plans. Half-hearted, fragmentary efforts by separate entities simply will not do the job.

A functional, soundly based regional plan relating to coal development requires a body of background information that is currently lacking. Urgently needed are:

1. A comprehensive study of effective reclamation practices.
2. A detailed analysis of Montana coal to determine the amount of trace elements and heavy metals present.
3. More work on the effects of SO_2 and other emissions on the rangeland ecology.
4. A study of the problems associated with burial of fly ash in spoilbanks.
5. An in-depth study of government and industry research priorities. It would be important to know how much is being spent on the search for more efficient and less degrading means of electrical generation and transmission as well as for new generation techniques.
6. A comprehensive regional meteorological survey of the eastern one-third of the state.
7. Specific knowledge of the environmental problems involved in moving coal by slurry pipeline.

Above all, if the planning efforts of Montana and other coal reserve states are to have any hope of success, **the most imperative needs are for state self-determination in resource use and for a national energy policy and a national program to moderate energy consumption by encouraging conservative rather than maximum energy use.**

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Prospects for Spray Irrigation of Wastewater

Contributed by
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Introduction

At this writing, legislation is pending in Congress (S. 2770) which would eliminate all industrial and municipal sewage discharges into surface waters by 1985. Should the bill pass both houses in its present form it would require a radical realignment in our present attitudes toward waste treatment and disposal. With lakes and streams no longer candidates for receiving wastewater we would have to turn to the only other practical recipient – the land.

It is therefore imperative that we scrutinize the potential problems and benefits associated with land disposal of wastewater.

This paper describes the technique of land disposal of municipal wastewater and confined livestock manure by spray or sprinkler irrigation. It illustrates a number of applications and analyzes the feasibility of implementing the procedure in Montana. The "living filter" system – the functional, water-renovating basis of the spray process – is also described.

To place this approach in proper perspective, it may be helpful to begin with a background discussion of the nature and implications of current disposal methods for human and confined animal wastes in this country.

Standard Waste Disposal Methodology

Human Wastes

Our present water-transport system of waste disposal was developed near the middle of the last century to reduce the incidence and transmission of disease in large cities. At the turn of the century about 1,000 communities in the United States were sewered, and most of these discharged untreated waste into the nearest watercourse (17). When World War II ended, less than 75 million Americans were provided with sewer services, with roughly 30 million, or 40 percent, discharging raw wastes. Most recent estimates indicate nearly 70 percent (140 million) of our total population is sewered, seven percent of the nation's sewage remains untreated, while the bulk of the rest receives secondary (61 percent) or primary (31 percent) treatment before release into surface waters) (12).

Sewer systems, especially since the advent of the flush toilet, require an ample and continuous supply of fresh water as volume and vehicle for transporting waste. The average domestic sewage consists of 99.94 percent water (28). Some 23 billion gallons of sewage effluent were discharged daily during 1967 by municipal treatment plants in the United States (19). Little of this water remains to help recharge local aquifers. With groundwater now accounting for more than 20 percent of the nation's water supply (11), shortages have occurred in areas where rainfall alone has not been sufficient to replenish underground reserves (19) (23).

The development of water transport systems created the basis for another widespread problem, that of artificial nutrient enrichment of surface waters, also known as cultural eutrophication. Eutrophication is manifest by rank growths of aquatic plants (algae) known as "blooms." Algal blooms degrade the attractiveness of a body of water, create health problems, and interfere with recreational uses. Accelerated eutrophication also has significant long-term consequences such as oxygen depletion and a shift to more tolerant but less desirable fish species, carp for example.

The algae that compose blooms are limited in growth principally by the amounts of phosphorus and nitrogen in the water. Municipal sewage is a medium overly rich in phosphorus and nitrogen when considered in terms of the rather modest nutrient requirements of algae. Typical municipal wastewater contains 10-15 ppm (parts per million) total phosphorus and 25-35 ppm total nitrogen (33). Only tiny fractions of these amounts, 0.01 ppm phosphorus and 0.30 ppm nitrogen, permit algal blooms in lakes (13). Meanwhile, the nutrient removal efficiency of standard wastewater treatment plants is nowhere close to what is required to prevent eutrophication. Primary treatment facilities, designed mainly to reduce the oxygen-consuming organic carbon content of sewage (biochemical oxygen demand or BOD), remove only 5-15 percent of the nitrogen and phosphorus. Conventional activated sludge (secondary) systems remove about 30-50 percent of these nutrients (33).

The nitrogen, phosphorus, and other nutrients stimulating excess algal production in surface waters are derived initially from the bread on our tables from the crops in our fields. They are headed on a oneway trip to the oceans, where they will be unavailable for further agricultural use. With our present waste disposal system our soils remain largely unreplenished with nutrients, except by stopgap applications of commercial inorganic fertilizers.

Summarizing, in the words of an eminent Montana geologist, Dr. Charles C. Bradley: "River disposal of human waste, though cheap, involves a double loss of resources. On the one hand there is the polluted river; on the other, the depleted soil (7)."

Confined Livestock Wastes

Agriculture is the biggest producer of wastes in the United States (21). A portion of the total waste production remains in the pasture and rangeland, but an enormous volume accumulates in feedlots and buildings and must be collected, transported, and disposed of in an economical and inoffensive manner. Especially in Montana, where the amount of wastes produced by feeder cattle is greater than that produced by the human population (21), pollution caused by animal production facilities can be as detrimental to receiving waters as wastes from any other industrial or municipal source. In addition, feedlots have generally been located without regard to the topography and soil inventory (31), thus intensifying surface and groundwater contamination.

Manure management is one of the largest problems currently facing the livestock industry. Past emphasis has been upon recovery of the nutrient value of animal wastes by returning them in either solid or slurry form directly to the land, but even then both ground and surface water contamination can result as the soluble components, such as nitrates and chlorides, are leached into the ground and as runoff moves a variety of pollutants overland. Although runoff may dilute animal wastes, the concentration of pollutants in the runoff is much greater than in domestic sewage (21).

Land spreading is no longer an economic alternative, however, considering the immense quantities of manure to be disposed of, low cost and greater efficiency of inorganic chemical fertilizers, shortages of farm labor, transportation costs, and other factors (37).

Processes used for the treatment and disposal of municipal wastes have been applied to animal wastes without success, largely because of lack of understanding of the differences between animal wastes and domestic sewage, the magnitude of the problem, and the economic constraints imposed (21).

Need for Alternative

Eutrophication and decreasing freshwater resources, including groundwater, are listed as two of the world's eight most important environmental problems by a global scientific organization contracted by the United Nations (16). Considering the technology presently applied to human and animal waste treatment and disposal, the recent population expansion along with trends toward urbanization and centralized sewerage, and the recent boom in the confined animal production industry, there is little hope for mitigation of these problems in the near future.

However, a technology has recently arrived on the scene which, though still in its infancy, holds sufficient promise to be seriously considered as an alternative for treating and disposing of human and animal wastes — spray or sprinkler irrigation on crop, pasture (or range), and forest land.

The Living Filter Approach

Land disposal of treated and untreated domestic sewage has been used by man for centuries. The primary goal has been disposal of wastewater without producing a health hazard, rather than pollution abatement, increased groundwater supplies, or improved farm production. The soil has been used as a mechanical filter and in most cases overloaded beyond its capacity (24).

Recent investigations have shown that a deep soil with proper texture and structure and a continuous plant cover may provide far more than simple physical filtration for renovating wastewater, especially if wastewater is applied by spray or sprinkler irrigation (9, 22, 30). Other processes at work in the soil mantle are capable of removing impurities from a sprayed secondary effluent at efficiencies comparable to tertiary treatment, provided certain conditions are met. These additional processes include chemical combination, volatilization, ion exchange, biological reactions, and plant uptake. Because the spray irrigation system relies heavily on a viable community of bacteria and fungi in the aerobic soil zone and a surface cover of rooted vegetation, it has been popularized as the "living filter" (18, 19, 20).

Most of the information that follows on soil mechanisms for wastewater renovation is from the report of a recent University of Washington interdisciplinary assessment of the feasibility and effects of land disposal of a typical secondary effluent (9).

As wastewater percolates down through the soil column, bacteria and viruses are removed by a combination of physical filtration and biological competition and predation. In addition, positively charged viruses may be attracted to and removed by negatively charged soil particles (1). Almost all microbes are removed from the wastewater within a few feet of the surface, even in the coarsest soil.

Particulate organic matter (BOD) and suspended inorganic solids, which impart most of the opacity to wastewater, are almost entirely removed by filtration in the upper five to six inches. Dissolved organics, also contributing to the BOD, are removed by absorption to soil particles.

Dead bacteria and viruses, along with filtered and adsorbed organic matter, are eventually decomposed by microbial action and either reconsituted into biological cells or mineralized into inorganic materials that are taken up by plants, held in the soil, or transferred through the soil mantle with the water flow.

Phosphorus is removed by plant uptake and adsorption onto clay particles, the soil serving in this respect as a phosphate sink.

Nitrogen in various forms is removed by plant uptake. Under conditions where a vigorous growth of nonleguminous cover vegetation is maintained, a crop of corn for example, all of the nitrogen can be removed by plant uptake (18). Nitrogen can also be volatilized by denitrification to the gaseous form (N_2). In addition, where soils are alkaline, ammonia gas (NH_3) may form and escape to the air. Adsorption onto soil particles is effective in removing ammonium ions (NH_4), but nitrate-nitrogen (NO_3^-) is relatively undiminished by the adsorption process (33).

Heavy metals are usually withdrawn by fixation on insoluable hydrous oxides of manganese and iron. Other means of removal include adsorption onto clay particles, fixation by organic matter, and chemical precipitation.

Cations and anions, calcium and bicarbonate for example, are only partially removed because of the need to balance electrical charges in the soil and water systems. Ion exhange, however active it may be, is not renovation but rather a substitution of one ion complex for another. Potassium is removed much more effectively than other cations because of its dynamic nature in both soil and plant systems. The primary mechanisms involved in removal of cations and anions are chemical precipitation and fixation and plant uptake. The cation sodium, and the anions chloride and sulfate, are not renovated in the soil system and pass through virtually undiminished.

Table I portrays the expected removal efficiencies for various wastewater constituents under a given set of conditions (9).

It is apparent from the figures in the following table that the renovative capacity of soil is high. According to a recent Environmental Protection Agency report (12):

> **Water reaching watercourses after passage through the filtering and decomposition processes afforded by soil is far purer — provided that soil loading rates are not exceeded — than any waste treatment process short of distillation could make them (sic).**

Table 1. Estimated effectiveness of spray irrigation in removing various wastewater constituents given the following conditions: Effluent used from a secondary treatment process and applied at a rate of two inches in eight hours once a week; soil a silt loam five feet deep with a carbon to nitrogen ratio greater than 15; climate typical of the Great Lakes region; vegetation continuous (9).

Constituent	Percent Removal
Biochemical oxygen demand	99
Suspended solids	99+
Total nitrogen	80-90
Total phosphorus	99
Heavy metals	99
Organic compounds	99
Viruses	99+
Bacteria	99
Cations	75
Anions	0-50

When compared to the amount of water absorbed by the soil, the amount of water released by evapotranspiration is generally modest (22). In one study, 60 to 80 percent of the water applied to the research areas found its way to the groundwater reservoir (30).

The living filter, as a system for renovating wastewater delivered by sprinkler irrigation, is usable wherever the following soil conditions prevail. An infiltration rate rapid enough to accommodate irrigation water the year round but slow enough to allow interaction with plants and microbes, a high exchange capacity, a high sustained rate of percolation (greater than 0.5 inches per hour) to permit vertical drainage and maintain aerobic conditions, and a soil mantle thick enough (five feet or more to bedrock or groundwater) to insure renovation of the effluent before recharge to the groundwater reservoir (9, 20). Sites with these conditions as well as a suitable climatic regime have been located in California, New England, and the Great Lakes states (9).

Other prerequisites for optimum efficiency of the system are a high carbon to nitrogen ratio in the soil, a continuous vegetative cover, and careful management, including intermittent application allowing for maintenance of aerobic conditions, discontinuance of operation when air temperatures are significantly below freezing, and harvest of the cover vegetation by cropping or grazing.

Under these conditions a secondary effluent can be applied at a rate of about two inches per week with a high degree of effectiveness and without concern for surface or groundwater contamination (9).

Applications of the Living Filter

Human Wastes

Large-scale applications of domestic wastewater to agricultural land have been conducted for some time in various parts of the world. For example, the city of Melbourne, Australia has been using untreated municipal sewage to irrigate pastureland since 1896. The area involved is about 25,000 acres. The population served is a little under two million (3).

Mexico City, with about seven million people, transports its raw sewage by pipeline 25 or 30 miles to a basin from which irrigation water is drawn. The sewage undergoes some decomposition and is then distributed to farmers who desire the so-called "black water" for agricultural use (42).

Interest and activity in the United States were stimulated by the wastewater renovation and conservation project at Penn State University in 1962 (30). This was the first sophisticated, scientifically assessed application of the living filter concept in this country. About a half million gallons of wastewater from the university community were applied daily through revolving sprinklers upon nearby farm and forest lands at a rate of about two inches per week over a three-year period. Close observations were made of surface and groundwater quality, groundwater recharge, crop production, and tree growth. The investigators concluded that land disposal of large volumes of sewage effluent is feasible (19).

Since the Penn State study, a number of small-scale research and demonstration projects have been initiated around the country (8, 14, 39, 40, 45, 46) but none have been so ambitious as the Muskegon County (Michigan) wastewater management system (1) scheduled to begin operation by the end of 1972.

The Muskegon County system proposes to spray irrigate and rebuild 6,000 acres of depleted and marginal agricultural land with municipal and industrial wastewater from a population of about 170,000. The system will replace four existing municipal treatment facilities with a present total flow of 11 million gallons per day and eliminate the direct discharge of five industrial plants with a combined flow of 19 million gallons per day.

The same engineering firm that designed the Muskegon County system has completed a preliminary feasibility study on land disposal of sewage by spray irrigation for the Cape Cod area (2) and is currently designing a system large enough to serve 11 million persons in metropolitan Chicago (3).

In Montana, a number of small communities, trailer courts, and recreation developments propose to spray irrigate their sewage (44). In some cases, however, this is only an alternative disposal method contingent upon the success of seepage and evaporation cells (lagoons) in handling peak waste loads. A large recreational complex in the Gallatin Canyon intends to manage the sewage from part of its development by installing two tertiary treatment plants and spray irrigating the effluents on its golf course (26). The State Department of Health and Environmental Sciences' water quality project plan for Missoula considers the option of spray irrigating primary sewage in lieu of secondary treatment (25).

Confined Livestock Wastes

Certain livestock wastes are amenable to liquid treatment and disposal methods. These include washings from dairy operations and collected runoff from feedlots. Although the resultant wastewater is significantly different in many respects from domestic sewage, it is, after dilution and a period of stabilization, in a form suitable for application by spray irrigation. Unlike solid manure and slurry disposal methods, spray irrigation allows for applying animal waste nutrients directly to growing field crops.

The living filter technique for utilizing and treating liquid livestock wastes was recently demonstrated by a state legislator on his family dairy farm in Pennsylvania (32). The manure from 200 cows was mixed with fresh water and stabilized in a series of three shallow lagoons. Wastewater from the lagoons was applied by spray irrigation over a variety of grain and forage crops and nursery tree stock in summer and over hardwood forest in winter. The growth response of the irrigated plants was remarkable. No surface or ground water contamination was detected at an application rate of two inches per week.

The giant Monfort feedlot near Greeley, Colorado has been spray irrigating the ponded runoff from its facilities for about 10 years without apparent ill effects (29).

Feasibility for Montana

In considering the feasibility of implementing large-scale spray irrigation projects in Montana, we must ask and attempt to answer a number of questions.

First, is there a need for departure from our present disposal system in light of the severity and sources of eutrophication, the adequacy of groundwater resources, the fertility of agricultural and forest land, and the possible future requirement for zero discharge in Montana?

Second, are the immediate problems and potential long-term adverse impacts associated with spray irrigation of sewage in Montana adequately documented and of sufficiently minor consequence to warrant commencing full-scale operations?

And finally, are the climate, soils, natural and agricultural vegetation, and hydrologic and geologic conditions in the state amenable to land disposal of sewage? This last question is, at least superficially, the easiest to answer. Montana is a large, diverse state with a wide range of these conditions in a variety of combinations. Certainly if spray irrigation of sewage is feasible for California, the Great Lakes states, and New England (9) it will be feasible for many parts of Montana. The critical factor seems to be the soil, which will have to be evaluated on a local basis with the aid of a Soil Conservation Service map.

Analysis of Benefits

To answer the first question, "Is there a need for departure from our present system?," we must look at the benefits to be gained in Montana from switching to spray irrigation of our sewage. As noted previously, the major advantages of a land disposal system are alleviation of eutrophication, recharge of groundwater reserves, enhanced soil fertility and crop production, and a means of achieving the no-discharge policy that may be required by law in the near future, depending on the fate of the controversial "Muskie bill." An evaluation of each of these potential benefits in light of the present state of affairs in Montana follows:

Alleviate eutrophication: Eutrophication is a problem in Montana, particularly in a number of lakes and reservoirs in the western portion. In most cases, however, it is difficult to assess the actual source of nutrients creating the problem. Moreover, in many lakes municipal sewage can be ruled out as the culprit. Georgetown Lake, for example, is a water in advanced stages of eutrophication that receives no community effluent. The same may be said for a number of isolated pothole lakes in the upper Flathead Valley. Other factors have been responsible for nutrient enrichment and excessive plant growth in Georgetown, including septic tank discharges from individual homesites, watershed management practices, lake morphometry, and bank erosion (15).

In Montana we discharge most of our community wastes into streams and rivers. Often they are either too cold and rapid (Gallatin River) or too turbid and with a bottom too unstable (lower Missouri and Yellowstone Rivers) to support a sizeable aquatic flora. In other words, nutrients may be sufficent for algal growth in these waters, but low water temperature, rapid current velocity, substrate instability, and poor light penetration are preventing blooms from appearing and creating a nuisance.

On the other hand, where gradients moderate or cease and where water becomes warmer and clearer, algae may proliferate and cause problems, as in reservoirs such as Canyon Ferry. One must not be too quick to blame sewage outfalls for reservoir water quality problems, however, since reservoirs are inherently excellent nutrient traps and have been known to become highly eutrophic with little or no added introduction of cultural nutrients.

In summary, it is exceedingly difficult to assess the singular impact of domestic sewage effluents on surface water quality in Montana and to predict the effects on these waters of their removal. Certain chronic eutrophication problems are definitely not caused by community sewage outfalls. Industrial and agricultural wastes, particularly runoff from fertilized fields and feedlots, probably contribute as great or even a greater share of nutrients that stimulate algal growth in surface waters than do community wastewater discharges.

Recharge of groundwater reserves: Groundwater reserves appear to be adequate throughout the state for domestic and stock purposes but largely untapped and of unknown supply for other uses. Groundwater recharge in eastern Montana is by precipitation only and quite modest because of the semiarid climate (41). Although many eastern Montana communities have difficulty in obtaining an adequate supply of good quality water, this is a problem inherent in the delivery potential of the aquifer and not a man-caused situation.

Two cases of locally heavy industrial water use have caused significant depressions in groundwater tables in both western and eastern Montana, most notably water use associated with secondary oil recovery operations in Prairie and Fallon counties. With the renewal of interest in coal and water development in the southeastern sector of the state, and with recent talk of tapping underground reservoirs for irrigation, the use of subsurface water in Montana can be expected to increase substantially in the near future (10). Groundwater recharge would then be more crucial than it is today.

Enhance soil fertility and agricultural production: Montana has over 230,000 acres of the best agricultural land available — Class I irrigated (38). To spray irrigate the wastewater from the entire sewered population of Montana (about 450,000 persons) under the conditions described in this paper would require about 18,000 acres of land, determined by extrapolating figures from the University of Washington study (9) presented in Table 2. This acreage adjustment is necessitated by a limited growing season in Montana, as explained below. Considering the several millions of additional acres of Class II-IV lands in the state, the increase in total agricultural production resulting from the application of human waste nutrients to another 18,000 acres would be insignificant.

However, since many Montana soils are deficient in nitrogen and phosphorus and most crops throughout the state are responsive to additional moisture, especially in regions where rainfall is below 12 to 14 inches annually (29), spray irrigation of domestic wastewater can be expected to substantially enhance soil fertility and production and nutritional value of crops wherever it is practiced. The application of feedlot and dairy wastes in the same fashion would have a similar effect on soils and crops and at the same time remove these wastes as threats to water quality.

Attain zero discharge: It is conceivable, with passage of the "Muskie bill" or similar legislation, that by 1985 municipal sewage discharges into surface waters will be outlawed in Montana as elsewhere throughout the nation. The state is well along in its treatment plant construction program and by 1977 all sewered villages, towns, and cities of Montana will have the equivalent of secondary treatment for their wastewater (44). At that time every municipal sewage effluent in the state will be at the stage of treatment desirable for spray irrigation.

Land disposal would be one method of achieving the goal of no discharge. If the living filter approach is utilized as outlined previously, wastewater would receive the equivalent of tertiary treatment and potable water would be returned to the underground aquifer.

Table 2. Land requirements for varying populations using the spray irrigation method of wastewater disposal, assuming an application rate of two inches per week and production of 100 gallons per person per day (9).

Population	Acres	Square Miles
1,000	12.9	0.02
5,000	64.5	0.1
25,000	322	0.5
50,000	644	1.0
75,000	967	1.5
100,000	1,289	2.0
500,000	6,446	10.1
1,000,000	12,890	20.1

Analysis of Problems

A number of immediate problems and potential long-range impacts from spray-irrigating sewage have been anticipated, mostly by those unfamiliar with the living filter concept and the mechanisms involved. Some of these objections are valid, others are not.

Spray irrigation of sewage for wastewater renovation is a technology designed to alleviate a specific problem — principally surface water eutrophication. Like other technologies, it creates certain problems of its own which should be reckoned with before it is applied. And like other sewage treatment and disposal systems, it can be limited in effectiveness or subject to operational failure by the quality of management it receives.

The following analysis of the major real and potential problems associated with spray irrigation of wastewater may place them in their proper perspective on the Moontana scene. By weighing these difficulties against the benefits outlined in the previous section, we may arrive at some conclusions about implementing this technology in Montana.

Land requirement: The living filter method of wastewater treatment and disposal requires a significantly greater amount of land than more conventional processes achieving the same degree of treatment, particularly if care is taken to provide enough surface area to avoid overloading the biological, physical, and chemical renovative capabilities of the natural soil system.

The Table 2 land requirements for varying populations using spray irrigation at a rate of two inches per week are grossly inadequate for Montana, since it is assumed in those figures that irrigation can be practiced the year round and therefore that little or no land is required for lagoon storage. Winter applications of sewage have been tested successfully only on hardwood forests, which are limited in Montana. For must efficient treatment in the state, all of the yearly wastewater production would have to be applied within the summer growing season, which averages about 120 days. This would necessitate three times the land area required for continuous year-round application. In addition, lagoon storage would have to be provided for the remaining two-thirds of the year when spraying is not feasible.

Taking these factors into account, an appropriate land requirement figure for Montana is approximately 18,000 acres. This is less than one percent of the total irrigated acreage in the state and less than one-tenth of one percent of all agricultural land (38). Accordingly, wastewater irrigation systems for Montana's largest cities, Billings and Great Falls, would each require about 3,000 acres of land.

National proponents of land disposal of sewage by spray irrigation report that only about one percent of the total cropland in the country, or 7.2 million acres, would be required to treat our entire wastewater output at the recommended rate of application (1, 43). Furthermore, they claim it would be economical for large metropolitan areas to transfer their sewage 150 miles to suitable agricultural land rather than build advanced treatment plants for removing algae-producing nutrients (4).

Cold weather operation: A wastewater irrigation system utilizing deflector-type stationary sprinkler heads has been developed for year-round application in temperate climates (27). The system has operated well in application on hardwood forests throughout two Pennsylvania winters, including prolonged subzero periods (27, 30).

Winter irrigation of domestic and dairy wastewaters has been successful when applied to deciduous woodlands in Pennsylvania (30, 32). The dormant trees were relatively unharmed by the substantial ice accrual, and the spring meltwater was easily accommodated by the deep humus on the forest floor. Agronomic crops, because harvesting each year removes nutrients from the fields, are more efficient wastewater renovators than forest crops, which recycle some of the nutrients by leaf fall. Winter or summer spraying of woodlands would therefore not be as efficient in renovating wastewater as summer spraying of crop or pasture land, but decidedly more efficient than application on bare ground.

Deciduous trees in Montana, however, are largely confined to along major watercourses and to patches on higher mountain slopes, those in suitable locations would generally be insufficient for winter irrigation.

Although conifer forests are proximate to several western Montana communities they are untested from the standpoint of response to cold weather spraying. Dormant grasslands (rangeland and pasture) may be considered candidates for winter as well as summer irrigation, but ice buildup and springtime runoff may render these even less desirable than fallow soil.

Sewage lagoons: Considering the paucity of hardwood forests, the only viable alternative to winter spraying in Montana appears to be lagoon storage.

In addition to the land area required and possible sealing difficulties, lagoons present other problems, most notably emission of odors during the annual spring turnover, possible pathogen carryover, evaporation and concentration of dissolved solids, insect (mosquito) nuisances, and prolific algal growth (34). On the other hand, a properly designed lagoon that is not overloaded can provide service superior to that of an activated sludge treatment plant and be free of objectionable odors (3).

Lagoons have served adequately at 133 locations throughout Montana without serious trouble. According to statistics supplied by the Montana Department of Health and Environmental Sciences (41), better than 85 percent of the sewered populations of the Big Dry and Two Rivers regions rely on sewage lagoons for their wastewater treatment. Significant percentages of the populations of each of the remaining five environmental regions are also serviced by lagoons.

Pathogens: It has already been stated that microorganisms are efficiently removed from wastewater within a few feet of the surface by the soil system. The chances for groundwater contamination are therefore slim. Nevertheless, an effluent considered for land application should be thoroughly disinfected before it reaches the soil or growing crops. And even then, infection would be possible as there is always the possibility of chlorination failure and disposal of wastes not disinfected (9).

With this in mind, crops directly destined for the dinner table, such as potatoes and green vegetables, should not be irrigated with wastewater. In Montana, more acceptable recipients would be pasture, corn, hay, and small grain crops (29).

Human pathogens that can be transported with feces in sewage are bacteria of the genera *Shigella* and *Salmonella* and viruses believed to be the causative agents of poliomyelitis and infectious hepatitis. *E. coli* is of intestinal origin but usually not considered a pathogen, rather, its presence is used to indicate the presence of pathogens. Other members of the coliform groups are found naturally in the soil and respond positively to the general coliform test.

According to the University of Washington report (9), regrowth of microorganisms that normally reside in the intestines of warm-blooded animals should not occur in nature because they are not adapted to that environment, but regrowth can occur in members of the indicator group that are normally found in nature. In some instances, organisms from intestinal origin have survived well in the soil.

The persistence of these organisms in soil is of considerable interest in the event that contact with humans is possible, although such direct contact is remote. The concentrations of pathogens remaining in the soil after spray irrigation would probably be low because disisinfection of the wastewater would be a prerequisite to land disposal. Although the effectiveness of pathogen removal, particularly viruses, and the validity of the coliform index are controversial subjects, it appears that routine disinfection practices are effective in removal of all pathogens, bacterial and viral (9).

Air dissemination of surviving pathogens from wastewater spray sites and lagoons should be considered as a possible hazard. Tiny droplets emitted by bursting bubbles from activated sludge plants and aerated or wave-tossed lagoons may contain concentrations of bacteria much greater than the parent solution and are capable of being transported for some distance downwind (5). Spray irrigation would probably expose a small percentage of the wastewater particles to wind action (9), but irrigation machines directing the spray downward under low pressure would minimize aerosol effects (1).

The presumably minimal opportunity for wind removal of particles from sprayed droplets, together with the very low probable concentration of human pathogens in the wastewater, suggests that the hazard of airborne transmission of disease from spray fields to people would be slight. Even so, sprayed areas should be kept at a considerable distance from residential areas (9).

High moisture levels are favorable to plant pathogens dependent on water for dissemination of spores, such as species of Phycomycetes. In addition, many pathogens benefit from host susceptibility induced by high moisture. The limited research available on the effects of irrigation versus plant pathogens all points in the direction of increased problems (9). Nevertheless, in one experiment corn blight was brought under control on acreages sprayed with dairy wastes in Pennsylvania (32).

Soil degradation: The most significant cause of soil clogging is the activity or lack of activity of microorganisms (22). The conversion of dissolved organic matter into a biological sludge made up of cells and the failure of microorganisms to decompose filtered particulate matter can clog soils and thus greatly restrict the infiltration rate (9).

Once-a-week applications of wastewater, allowing for maintenance of the aerobic conditions most favorable for organic decay and mineralization, will preclude possible clogging problems. Under the soil conditions outlined earlier, and at a loading rate of two inches (11.5 pounds BOD per acre) per week, soil clogging is unlikely to occur (9).

In arid or semiarid regions where precipitation is less than evapotranspiration, soluble salts accumulate at varying depths in the soil profile. Sewage ordinarily contains about 300 ppm more dissolved solids (salts) than were in the original water supply, the greatest constituent increases being in sodium and chloride (34). Salt accrual has caused many irrigation systems to fail (3). In dry regions it is therefore particularly important to use plenty of leaching water and a high-capacity drainage system to avoid this problem.

Most heavy metals can be expected to concentrate in sludge and sediments, and very low concentrations should occur in the effluent. The concentrations of toxic elements expected in treated sewage effluent contribute very small quantities of heavy metals per acre per year and should not create problems for several centuries.

Concentration of heavy metals in excess of those in treated domestic effluents are not desirable in the aquatic system, nor are they desirable in the soil system. We must be specific as to what industrial materials are to be allowed into municipal treatment systems whether wastewaters are to be disposed of on land or in water. Heavy metals should be removed prior to acceptance into any municipal system.

Conclusions

1. The spray irrigation technique for disposal of secondary treated domestic wastewater has been proven safe and effective, provided careful site selection, system design, and management are exercised.
2. It is apparent that many areas in Montana have the proper combination of climate, soils, crops, and hydrologic and geologic conditions to qualify for spray irrigation of sewage.
3. The need to adopt land disposal of municipal wastewater in Montana for the single objective of alleviating eutrophication is unsubstantiated at this time; other pollution sources, including agriculture, agribusiness and related industries, logging, and rural, second-home, and recreational residences, are now contributing more to Montana's eutrophication problem than municipal discharges.
4. The increase in crop yield in Montana as a result of spray irrigating sewage nutrients would be insignificant when compared to the state's total agricultural production, the benefit to local soils, crops, and thereby economies may be significant, however.
5. In light of expected demands for groundwater, recharge of underground supplies will be more crucial in the near future, particularly in semiarid Great Plains Montana.
6. Land disposal of municipal wastewaters would provice an excellent means for avoiding surface water discharges that would be outlawed by legislation pending in Congress.
7. The soil degradation and pathogen problems associated with broadcasting human wastes over agricultural land immediately adjacent to municipalities do not appear to be significant enough to warrant abandoning consideration of the practice at this time, although more research is needed; the land area and lagoon storage requirements are minor problems in Montana in light of the abundant land resource and the widespread and established use of sewage lagoons in the state.
8. Confined livestock wastes are not nearly as amenable to spray irrigation as are domestic wastewaters, nor has such irrigation of animal wastes been tested sufficiently to warrant commencing large-scale operations in Montana at this time. Other disposal and reclamation processes, such as those yielding oil or methane gas (6, 35, 36) should be seriously considered in lieu of spray irrigation.
9. Only those systems utilizing secondary or more thoroughly treated wastewater have been proven safe and reliable, most of the research and development to date has been conducted using secondary effluents.

Recommendation

An interdisciplinary study team should be established to conduct an in-depth investigation into the feasibility of spray irrigating municipal wastewater in Montana. The objectives of this task force should include (a) development of system design and management practices commensurate with climate, soils, crops, and hydrologic and geologic conditions prevailing in the state, (b) identification of land areas and municipalities within the state suitable for spray irrigation, and (c) documentation of the effectiveness and effects of the system at selected locations, particularly with regard to possible soil degradation and pathogen problems.

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Chapter 5

THE PROPOSALS

Introduction

Montana has only a short time in which to break out of century-long colonial status. The recent exploitative trends in coal and water and in speculative land development have been noted in preceding chapters. The Environmental Quality Council, on July 21, 1972, adopted a number of recommendations for legislation, programs, and state policy studies that would enhance the state's ability to guide its own future. Proposed legislation will be drafted for the next legislature by the EQC and/or appropriate state agencies. Montana must seize the remaining opportunities for self-direction or lose the environmental quality and diversity that are her true and lasting wealth.

As this report goes to press, the Environmental Quality Council has been informed that Governor Anderson has implemented the council's number one priority for state policy studies – the coal task force – in response to the council's resolution of April 7, 1972 on this subject.

Cooperation and coordination of this kind between the executive and legislative branches is an important first step toward developing governmental capacity to foresee and modify the long-term consequences of actions taken for short-term benefit.

Following are the EQC recommendations adopted on July 21:

Recommendations

Legislation

1. Amendment of the Open Cut or Strip Mined Land Reclamation Act to provide permit authority; to authorize selective denial of permits where there are excessive slopes, overriding scenic or archeological values, or where for other reasons adequate reclamation is not possible; and to authorize control of the mining method in steep areas.

The Open Cut or Strip Mined Land Reclamation Act (50-1018 et seq.) currently specifies that operators must enter into a contract with the Board of Land Commissioners providing for the reclamation of disturbed lands. The problem with such a procedure is that contracts are not reviewable. Although the model contract used by the Department of State Lands can be revised, the revisions affect only subsequent contracts, not subsequent operations under an existing contract. In other words, once a contract is signed, its provisions hold even if new circumstances of significant environmental import come to light. This is in contrast to provisions of the Hard Rock Mining Reclamation Act, which specify permit authority and provide procedures for the denial of a permit subject to administrative and judicial appeal. Permit authority would also allow the land commissioners to ask for the resubmission of a reclamation plan as new environmental problems are encountered. This is especially crucial in strip mining, since data on effective land reclamation are lacking. It is not clear that such reclamation is a possibility. To allow the board to update its requirements during the reclamation process may be the only effective way to assure adequate reclamation of mined lands.

The act also does not provide for selective denial of permits where there are overriding scenic, cultural, historic, archeologic, or natural values that would be destroyed; where there are excessive slopes, or where for other reasons adequate reclamation is not possible. This again is in contrast with the Hard Rock Mining Reclamation Act. To grant this authority would give an agency the power to consider all relevant factors and determine if effective reclamation can be carried out. Such authority should be accompanied by specific guidelines for citizen participation and judicial review. Currently, the act requires review only by an advisory committee and the affected industry for revision of the reclamation plan. The environmental impact statement procedure would improve the quality of citizen efforts by providing comprehensive and timely information on permit deliberations.

In addition, the method of mining in steep areas should be specifically regulated. The choice of techniques — contour stripping, auger mining, etc. — can have serious and divergent environmental impacts in specific cases. Assessment of the various methods in each case could reduce environmental impacts.

The above amendments will be drafted in consultation with the Department of State Lands. (See 1971 legislature, Chapter III and agency programs and activities, Chapter IV.)

2. Amendment of the Open Cut or Strip Mined Land Reclamation Act to specify required standards for an adequate reclamation plan, including topsoil reclamation and maximum allowable slope.

The act currently refers to a "reclamation model contract" prepared by a select committee on mined land reclamation contracts. None of the provisions of the contract are included in the statute. Some of the most important requirements of an adequate reclamation plan — whether contract or permit — should be specified in the law. These include topsoil reclamation, the use of stable and diverse native vegetation, and the maximum allowable slope for the reclaimed land. These amendments will also be drafted in consultation with the Department of State Lands. (See Chapters III and IV as above.)

3. Amendment of the Hard Rock Mining Reclamation Act to cover dredge mining more adequately; alternatively, the enactment of specific dredge mine reclamation legislation.

The Dredge Mining Regulation and Land Preservation Act of 1969 (50-1101 et seq.) was declared unconstitutional because it violated equal protection standards by excluding certain other mining activities from its coverage. Since that time, dredge mining has been regulated under the Hard Rock Mining Reclamation Act. That act should be amended to cover dredge mining specifically, even though implicit authority may be sufficient. Alternatively, a new act could be drafted with an eye to the equal protection difficulties. The former course is preferable. In either case, renewed interest in dredge mining indicates that it should be regulated by statute as are all other types of mining. (See 1971 legislature, Chapter III and agency programs and activities, Chapter IV.)

4. Amend the law restricting the application of assessment work to 10 contiguous claims to permit such work to apply to all contiguous claims.

(A full discussion of this problem is in the 1971 legislature section, in Chapter III.)

5. Authorization of an appropriate state agency with suitable environmental expertise to regulate siting of power plants and routing of railroads, pipelines, transmission lines, and aqueducts.

At present, Montana has no siting and routing authority *per se*. Certain aspects may be regulated as, for example, when a pipeline traverses state lands and a right-of-way permit is required, but this usually affects only a small portion of a proposed route. Effective planning requires that the state be given authority for complete regulation of routing and siting. With this authority, the regulating agency can minimize or eliminate environmental and social disruptions caused by undesirable power plant sites, transmission line routes, etc.

6. Amendment of laws regulating subdivisions to close loopholes for environmentally questionable land transactions. Amendment of the sanitary restriction clause to require the subdivider to submit information on water supply and sewage to the Department of Health and Environmental Sciences.

Subdivision laws now on the books allow a hodge-podge of development and leave little room for planning. Many loopholes must be closed if this situation is to be rectified. For example, the subdivision laws should be amended to cover parcels of land up to 35 acres, as in Colorado law. Another loophole is that which allows land transactions to be carried out through the old metes and bounds method instead of through the filing of plats. To plug this loophole, the subdivision laws should be amended to require that plats to be filed in all land transactions.

The sanitary restriction clause presently requires private holders of individual parcels of land to submit information on water supply and sewage. The recommended amendment would shift this burden to subdividers. Enforcement would be enhanced by focusing on one area developer instead of on numerous individual landholders. A bond would be required to insure compliance with the subdivision law. (See discussion of subdivision regulation, Department of Health and Environmental Sciences, in agency programs and activities section, Chapter IV.)

7. Protection of prime agricultural lands from urban development through enactment of appropriate statutory land use tools such as zoning, tax incentives, and/or a site permit system.

The location and growth of most urban areas was initially determined by their proximity to productive agricultural lands. Continuing urban expansion and attendant phenomena such as highway construction have jeopardized the very lands that were in large part responsible for the origin of urban areas. To protect these lands, the state will have to be empowered to use the land use tools already mentioned — and perhaps others. (See Beartooth Foreland, Chapter II.)

8. A Scenic Waterways and Shoreline Protection Act to enable designation of certain waterways and to restrict alterations.

An act of this type is an effort to preserve various aspects of free-flowing rivers and important lakes. These include scenic, historic, archeologic, and recreation values, fish and wildlife habitat, and botanical and other natural conditions. The recommended act would balance construction of impoundments and shoreline developments with a program of preserving the distinctive natural values of rivers and lakes. Various classification categories can be established to permit appropriate and flexible management of diverse waterways. These range from areas of strict preservation to areas of environmentally compatible development. Procedures for classifying waters in a more highly protected status upon restoration should also be included.

An important feature of such an act is protection of the ecologically fragile land-water edge. This zone of contact is particularly significant both for the species it supports and for its contribution to water quality. (See Columbia Rockies and eutrophication paper, Chapter II.)

9. **Amendment of the Floodway Management Act from a 50- to a 100-year flood standard. Amendment of the intent and purpose of the act to urge local governments to enact regulations based on available information rather than wait for the completion of formal delineation studies.**

The 50-year flood standard is uncommon in floodway management acts. Federal law, and the laws of some other states, prescribe a 100-year standard. The amendments recommended by the EQC support the proposal made by the Department of Natural Resources and Conservation to the governor in 1971. (Discussion of delays in implementation of the Floodway Management Act is in the 1971 legislature section, Chapter III.)

10. **Repeal of Sections 80-601 through -605 (RCM 1947) which grant an automatic permit to anyone who wishes to build wharves or docks; review of dredge, fill, and bulkhead operations by an appropriate state agency.**

The above sections of the codes grant such automatic permits on navigable waters. Because wharf and dock operations are attended by currently unassessed environmental impacts, this 1909 statute should be changed. Specifically, the Department of Natural Resources and Conservation should be given permit authority for wharves and docks, for dredge, fill, and bulkhead operations, and for all such encroachments on public waters. Placing authority with this agency would enable coordination with the Floodway Management Act. The legislation should be written so as not to limit the application of the Stream Preservation Act. (See eutrophication paper, Chapter II.)

11. **Authorization of the Department of Natural Resources and Conservation to investigate and inspect potential environmental hazards during construction of impoundments. Also, require seismic investigation of all proposed sites of large dams relative to the resolution adopted by the Environmental Quality Council on April 7, 1972.**

The dam and dike safety laws (89-701 et seq.) do not specifically permit the Department of Natural Resources and Conservation to inspect dams and dikes during the crucial phase of construction. Such inspection could save the time and expense of faulty construction and could safeguard environmental health and safety. (See 1971 legislature, Chapter III.)

The EQC adopted a resolution recommending that full seismic investigation of all proposed sites for large dams be conducted "... before securing authorization or financing for such construction." These investigations should include comprehensive seismic studies well before, during, and after reservoir filling. Also necessary are geologic studies for faults, using microearthquake detection methods. Investigations should be timely enough and broad enough to permit full consideration of alternative sites. (See Columbia Rockies, Chapter II.)

Recent tragedies in South Dakota and elsewhere demonstrate the need for the recommended precautions. The state agency vested with this authority should be directed to formally complain to federal agencies not complying with these requirements.

12. **Amendment of the Stream Preservation Act to apply to private as well as public alterations of streams.**

The Stream Preservation Act (26-1501 et seq.) has the admirable intent of preserving the natural existing fish and wildlife resources of the state. However, the act requires only public agencies to have plans for channel modification reviewed by the Department of Fish and Game. Because private activities can have adverse impacts equal to those of public agencies, the act should provide the same review procedures for private alterations that affect fish and wildlife habitat. (See 1971 legislature, Chapter III and agency programs and activities, Chapter IV.)

13. **Amendment of the Water Resources Act to specify conservation flow authority as a requisite part of the state water plan.**

The Water Resources Act comes very close to specifying conservation flow authority. Section 89-101.2(5) stipulates that "... the water resources of the state must be protected and conserved to assure adequate supplies ... for the conservation of wildlife and aquatic life." However, no conservation or minimum flow requirements to preserve habitat have been adopted by the Department of Natural Resources and Conservation. Requiring this as one of the duties attendant upon development of the state water plan would be a long step toward the preservation of water quality in Montana. (See Broad Valley Rockies, Chapter II for a discussion of dewatering of watercourses. See also agency programs and activities, Chapter IV.)

14. **Supplement the county records on water appropriations by a centralized filing system.**

Montana is one of the few states that does not have a centralized filing system for water appropriations. Records of these appropriations must be dug out on a county-by-county basis. A centralized filing system would save many man-hours, much money, and would be a considerable planning aid. (See agency programs and activities, Chapter IV.)

15. **An environmental protection act that would give any legal entity with appropriate standing the right to bring suit in district court and to intervene in administrative proceedings in order to protect environmental quality.**

This act would supplement existing legislation designed to protect the environment. State agencies often find themselves in the position of being unable or, because of political pressures, unwilling, to enforce all the environmental laws for which they are responsible. Recourse for interested parties — both within and without state government — is needed. Michigan has had such an act since late 1970. The first year of the Michigan act showed that fears of harassment and of a court system inundated with frivolous suits were baseless. During that year, approximately three dozen suits were brought under the act, most of them by state agencies. Plaintiffs in these suits by no means prevailed in all cases, and only a handful were dismissed as frivolous. The same standards used to determine frivolity in civil suits were found to be readily applicable to suits brought under this act.

Two factors probably account for the paucity of suits brought under the Michigan act. The first is simply that litigation is a serious, costly, time-consuming business and not something that can be undertaken lightly. The second is that the act contains no provision for monetary damages; if a plaintiff wins, he cannot collect actual or exemplary damages but can only have the court bring the offensive action to a halt. In addition, a court can require the plaintiff to post bond for court costs should he lose. Given these factors, the reason for a suit must be compelling.

16. **A disclosure law requiring all operators of commercial processes to file certain information, including effluent and emission data. Appropriate enforcement sanctions would be included.**

Keeping track of all the effluents emitted by all commercial processes in Montana is a considerable burden on state agencies. A disclosure law, such as the one recently passed by the State of Washington, would lighten that burden by requiring businesses responsible for effluents and emissions that affect environmental quality to file data at regular intervals. These data would concern effluents and emissions, business efforts at pollution abatement, and business research activities in the area of pollution control. Monitoring would be initiated at all effluent and emission sources. State agencies would be able to spot-check sampling methods and equipment. To ensure full compliance, appropriate sanctions would be enforced against all business that did not meet these requirements.

17. **Establishment of a program to promote reprocessing of junked autos.**

As noted in Chapter III (1971 legislature), Montana currently has no comprehensive program for reprocessing junked autos. Because autos — discarded at an annual rate of 25,000 in Montana — are a valuable source of reusable materials, such a program should be established. The legislation should include provisions for collection, transportation, and reprocessing of autos, the regulation of all junkyards, and the levy of adequate fees to support the program. Local governments might be encouraged to collect auto bodies, large appliances, and farm implements. (See citizen efforts, Chapter III.) The Department of Health and Environmental Sciences has proposed legislation on a similar program.

18. **Establishment of environmental noise standards and development of a noise control program.**

There is currently no authority for environmental or transient noise regulation in Montana. Basic enabling legislation is needed to grant the Department of Health and Environmental Sciences the power to establish and enforce such standards. The department has begun investigations in this area, as noted in the agency program and activities section of Chapter IV.

19. **Authorization of the Department of Health and Environmental Sciences to assess proposals and recommend specific action concerning the environmental health aspects of highway routing in a manner similar to the powers of the Department of Fish and Game under the Stream Preservation Act.**

No public health assessment of highway routing decisions now exists except in the review of environmental impact statements. With increased awareness that highway routing can have serious impacts on environmental health, review should amount to something more substantial than comment. The health department should assess all proposed highway routings that have potential adverse environmental health impacts. It should have the authority to require steps to mitigate any potential hazard, and it should have the power to compel arbitration if requirements are not met. The environmental impact statement procedure would give the department early notification of projects with potential environmental health impacts.

20. **Amendment of noxious weed control and mosquito abatement legislation to subject those programs to the environmental impact statement process.**

In carrying out noxious weed control and mosquito abatement programs, harmful chemicals are often introduced into the environment. The districts established for these programs are not specifically subject to the Montana Environmental Policy Act requirement of filing an environmental impact statement. Requiring these districts or an appropriate lead agency to prepare impact statements on their abatement programs would produce better assessments of the effects of the chemicals used in these programs and would facilitate discussion of alternative methods.

21. **Creation of an interagency environmental monitoring committee to standardize and coordinate federal and state environmental monitoring.**

Such a committee is necessary to define parameters to be measured, to standardize methods of observation, to coordinate programs, to eliminate duplication and prevent omissions, to provide for data handling and dissemination, and to coordinate with federal monitoring. (See introduction, Chapter II.)

22. **Funding the superintendent of public instruction to hire a supervisor of environmental education.**

The superintendent of public instruction has indicated that she will seek funds from the 1973 legislature to hire a supervisor of environmental education. The supervisor would assist the state's public elementary and secondary schools in setting up programs that would serve the local function of heightening environmental sensitivities and meeting the statutory requirements relating to conservation education (Section 75-7509, RCM 1947).

Programs

The Environmental Quality Council recommends:

1. **That all departments have an environmental coordinator and/or committee to supervise the impact statement process and to oversee the agency's environmental policies; further, that agencies with frequent impacts make the environmental coordinator a full-time position.**

Most state agencies will have to prepare environmental impact statements. To supervise the process at all stages, an environmental coordinator should be designated. Some agencies have already done this; those that have not should do so at the earliest possible time. (See EQC operations, Chapter IV.)

2. **That the Department of Fish and Game develop interim contingency plans for recreational sites which have been acquired but not yet developed. These plans should be drawn to insure that sites are not degraded prior to development.**

The department has developed an outdoor recreation plan that includes an acquisition program for recreation sites. An important part of the implementation of this program is the period between the acquisition and development of sites. The department should have contingency plans to protect sites during this interim. (See agency programs and activities, Chapter IV.)

3. **That the Department of State Lands complete a resource development plan as recommended by the 1967-1969 Interim Committee to Study the Diversified Use of State Lands; and that this plan outline potential uses of state lands and include a periodic report of proposed developments.**

Pressures on Montana's state lands have increased geometrically in recent years and will continue to do so in the future. A state resource development plan should be completed as soon as possible that will catalog state lands and outline all their potential uses. Such a plan will better enable the state to coordinate land uses and meet the needs of the people of Montana. (See agency programs and activities, Chapter IV.)

4. **That the Department of Health and Environmental Sciences further investigate sanitary landfill programs and alternatives, including an active pursuit of recycling.**

As noted in the agency program and activities section of Chapter IV, the sanitary landfill is not a long-term solution to the problems of refuse management. In fact, landfills are known to cause problems, e.g. groundwater pollution. Realizing this, the department should evaluate the current thrust of refuse disposal in Montana, paying special attention to opportunities for reprocessing valuable materials and recycling others with minimum environmental impact

5. **That the Department of Natural Resources complete the state water plan required by the Water Resources Act of 1967.**

The Water Resources Board — now in the Department of Natural Resources and Conservation — was required by the Water Resources Act of 1967 (89-101.2 et seq.) to formulate and adopt a multiple use water resources plan. The state still does not have the completed plan. With increasing demands for all uses of water, it is essential that this be accomplished. Montana water needs cannot be vigorously asserted until this plan is completed, nor can choices between competing uses be properly made. (See agency programs and activities, Chapter IV.)

6. **That the Department of Highways implement now the Outdoor Advertising Act and the Junkyard Regulation Act.**

As discussed in Chapters III and IV, the Outdoor Advertising Act has been implemented very slowly. Recent indications from other states are that they have removed a sizeable number of signs under their acts. The same could be true in Montana if this act were pursued as a high priority. The Junkyard Regulation Act is in similar straits. Junkyard screening projects occur at a slow rate and often await federal funding; in the past, federal funds have lapsed because they were not used. The junkyard removal provisions of the act have likewise not been implemented.

7. **That the Department of Highways create a truly interdisciplinary team for its impact statement, planning, and design processes according to the Environmental Quality Council recommendation adopted at its June 16, 1972 meeting: "That the Department of Highways utilize the services of an interdisciplinary design team, including the environmental design arts, in any study or restudy of design alternatives on this (Butte-Boulder I-15) and future highway projects."**

The Department of Highways is presently staffed primarily with personnel trained in traditional highway design and engineering disciplines. The demands placed upon the department by environmental considerations cannot be met by the department as presently constituted. To rectify this situation, the department must add people trained in such disciplines as ecology, hydrology, landscape architecture, wildlife biology, etc. This is not an all-inclusive list, but it gives some indication as to the direction and scope an interdisciplinary team must have. (See EQC operations and agency programs and activities, Chapter IV.)

8. **That the Department of Health and Environmental Sciences investigate land filtering systems for wastewater.**

(A full discussion of land disposal of wastewater is in Dr. Bahls' paper in Chapter IV.)

9. That the Department of Health and Environmental Sciences take further measures to achieve a fully integrated waste management program.

Lack of coordination exists within the Department of Health and Environmental Sciences concerning certain aspects of its waste management programs. The department has not been as alert to possible consequences of its actions as it should be. For example, the department shut down a number of septic tank pumpers in the Billings area by prohibiting use of an inadequate disposal site, but it neglected to provide an alternative means for disposal. Coordinated effort by the department would have precluded such a situation.

10. That the Department of Health and Environmental Sciences set up a program to prohibit the discharge of boat wastes into waters of the state and that it coordinate with appropriate agencies to provide adequate disposal facilities.

The department has adopted regulations under existing statutes prohibiting the discharge of untreated boat wastes (69.3505(2) and 69-3508.1), but enforcement of this type of regulation is difficult, if not impossible. A more effective approach would be that adopted by the Environmental Protection Agency: to prohibit all discharges and require the sealing of waste exits. Before doing so, the department should work with appropriate agencies to insure that adequate waste disposal facilities and enforcement personnel are available.

11. That the Department of Highways reassess its advertising policies with special attention to environmental impacts and alternative uses of advertising funds.

The amount of money spent in the department's advertising program is nearly twice the amount spent for litter removal. Nearly $350,000 annually was spent in the last two fiscal years on advertising. This outlay should be reassessed with a view to utilizing these funds for more pressing highway problems, including billboard regulation, litter removal, junked-auto reprocessing, environmental decision-making, etc. If advertising continues, promotion of congested areas such as Glacier and Yellowstone National Parks should be avoided. Redirecting use away from crowded areas will enhance the quality of the recreation experience and the resources involved. (See Columbia and Yellowstone Rockies, Chapter II and agency programs and activities, Chapter IV.)

12. The authority of the Board of Health and Environmental Sciences under the Occupational Health Act be reaffirmed and that steps be taken to assure federal cognizance of this authority.

The Department of Health and Environmental Sciences administers the Occupational Health Act, while the Occupational Safety Act is administered by the Industrial Accident Board. The latter has been designated by the governor as the lead agency for the receipt of funds under the federal Occupational Health and Safety Act. Because the federal act is primarily concerned with public health, and because the health department is the state agency charged with the administration of public health matters, the health board's authority in these matters should be reaffirmed and the department should be designated the lead agency for receipt of these federal funds. (See agency programs and activities, Chapter IV.)

Policies

The Environmental Quality Council recommends that the following policy studies, listed in order of priority, be initiated as soon as possible under legislative overview.

1. **Coal Task Force:** Establishment of an interagency task force to direct planning and policy-making in the development of the state's coal and water resources. To be comprehensive, such planning must include provisions for industrial, agricultural, residential, commercial, educational, communication, transportation, parks and recreation, and political systems as well as for a system of cultural amenities. (See council resolution of April 7, 1972, appendix.)

2. **State Land Use Policy:** Initiation of an interagency study to draft a state land use policy. The study should include, among others, legal and constitutional problems involved in a comprehensive state-wide land use policy, planning and zoning powers of state and local government; various planning and zoning methods, possible ways by which the resources of the state can be defined, classified, and inventoried, property tax rates and structure; alternative methods of property assessment, entitlement procedures and policies, and problems of administration and funding. The study should also determine steps necessary for compliance with the emerging national land use policy. An essential component of this study is determination of the carrying capacity of Montana's resources and their ability to sustain an optimum quality of life.

3. **State Energy Policy:** Initiation of a study leading to a state energy policy to enable Montana to contribute and respond to a federal energy policy. The study should carefully separate nationwide problems from those that are matters for action at the state level. The study should inventory known reserves, and consider, among others, the full range of possible energy sources, otpimal thermodynamic efficiency of energy sources, conservation of use through pricing methods, utility and industry rate structures, utility advertising policies, possible ways by which effluents from sources can be reduced, taxation policies, entitlement procedures (i.e., licenses, permits, etc.) and policies, and the most efficient means of administration.

4 **State Public Transportation Policy:** Establishment of an interagency task force to determine whether a state public transportation policy is desirable, and, if so, what form it should take. Particular attention should be paid to state highway policies and possible alternatives, to the growing problems of congested urban transportation, to problems of airport size and siting, and to better utilization of existing rail capacity.

Because the above studies involve fundamental and far-reaching questions, each should include full public participation at all stages from initiation to culmination. This means that public hearings with adequate publicity and ample advance information should be held, and that written opinions should be solicited and fully considered. Legislative committee hearings will afford additional opportunity for thorough consideration of these crucial issues.

APPENDIX A

Biographies

Members of Environmental Quality Council and Executive Director

Gary J. Wicks was born in Mullan, Idaho and came to Montana in 1965. He has a B.A. degree from the University of Montana. Since doing graduate work at the university, he has worked on the governor's staff and was recently appointed Director of the Department of Natural Resources and Conservation.

George Darrow, currently chairman of the Environmental Quality Council, was born in Osage, Wyoming and came to Montana in 1949. A geologist and resource consultant, he holds two degrees from the University of Michigan: an A.B. in economics and a B.S. in geology. Darrow has been a Republican state representative from Yellowstone County for two sessions, sponsoring the Water Resources Act, the Floodway Management Act, and the Environmental Policy Act. He is chairman of the Environmental Health Committee of the Comprehensive Health Planning Advisory Council, a director of the Montana Conservation Council, and a member of the American Institute of Professional Geologists, the Geological Society of America, and the American Association for the Advancement of Science.

Bill Christiansen has been in the Montana House of Representatives for eight years. In the 1971 session, he was minority floor leader for the Democrats. Christiansen was born in Fargo, North Dakota and attended North Dakota State University. He came to Montana in 1935 and now lives in Hardin.

James F. Fleming, Jr. was born in Nebraska and came to Montana in 1941. He is a Democratic state representative, a farmer-businessman on Flathead Lake near Polson, a director of the Montana Potato Improvement Association, and a member of the Knights of Columbus.

Chase Patrick was born in Salt Lake City. He came to Montana at an early age and is currently assistant vice-president of the Helena First National Bank. Patrick has been a Republican state representative since 1967.

Elmer Flynn, the vice-chairman of EQC, was born in Missoula and is now a rancher near that city. He has served as Democratic state representative (1963, 1965) and state senator (1967 to present). Most recently, in the 1971 session, he was majority whip in the senate. Flynn is a member of the Knights of Columbus, Eagles, and Moose.

Dick Dzivi was born in Kalispell. He is a graduate of the University of Montana and the University of Montana Law School. Dzivi is a practicing attorney in Great Falls and has been a member of the state senate since 1967, serving as Democratic majority leader in the 1971 session. He is a member of the Montana Bar Association and the Montana Trial Lawyers Association.

John Lyon was born in Shelby, where he now owns and operates a radio station. He attended Los Angeles City College, Northern Montana College, Texas Tech, and the University of Montana. Lyon has been in the state senate since 1969 as a Republican.

George McCallum was born in Conrad and now lives in Niarada, where he is a rancher and Christmas tree operator. He is a first-term Republican state senator. McCallum is chairman of the Hot Springs School Board and of the Eastern Sanders County Hospital District.

Warren Hook was born in Minnesota and attended the University of Montreal, University of British Columbia Law School, and Washington State University. Hook came to Montana in 1954 and is currently employed as environmental control manager for the Anaconda Aluminum Company plant in Columbia Falls. He is a member of the American Chemical Society, the Air Pollution Control Association, the Chamber of Commerce, and Rotary.

Harriet (Mrs. Donald) Marble was born in Petersburg, Virginia. She came to Montana in 1964, having earned degrees at Cottey College and Muskingum College. She also holds B.S. and M.S. degrees in wildlife management from the University of Montana. Mrs. Marble is a member of the League of Women Voters, the Wilderness Society, and the Montana Wilderness Association.

Michael J. McKeon is a practicing attorney in Anaconda, his birthplace. He attended Notre Dame and the University of Montana Law School. McKeon, a Democrat, recently served as a delegate in the 1972 constitutional convention. He is a member of the Montana and American Bar Associations.

William G. Walter is department chairman and professor of microbiology at Montana State University. He was born in Lake Placid, New York and came to Montana in 1942 after earning B.S. and M.S. degrees from Cornell. He later received a Ph.D. from Michigan State. Walter is a member of the American Society of Microbiology, the American Public Health Association, and the National Environmental Health Association.

Fletcher E. Newby was born in Lingle, Wyoming and has spent most of his life in Montana. He received a B.S. in wildlife technology from the University of Montana in 1949 and an M.S. in wildlife management from Washington State University in 1951. Before his appointment as executive director of the EQC, he was supervisor for the Department of Fish and Game in Billings. Newby had previously served in the same agency as state big game manager and state game manager. While in Billings he was deeply involved in Montana environmental concerns and originated such innovative programs as state recreational waterways. Newby's major research and professional interest has been mammalian ecology and human environment. He has authored or co-authored many papers on the mammals of Montana.

APPENDIX B

Definitions

Environmental Impact Matrix

Human Activities

Irrigated Farming: Activities centered around the application of water to cropland and pasture to enhance agricultural production.

Dryland Farming: Activities devoted to the production of a crop, whether grain, forage, or other varieties, without the artificial application of water.

Grazing: Activities based upon domestic livestock ranging and feeding on pasture and rangeland.

Agribusiness: Enterprises associated with the processing of farm products, including feedlots, poultry farms, packing plants, creameries, cheese factories, flour and feed mills, vegetable oil mills and sugar beet factories.

Mining: Extraction of mineral resources (except petroleum), including open pit and shaft mining of ores, strip mining of coal, and excavation of gravel pits or quarries along with related exploratory activities.

Mineral Processing: Enterprises devoted to the primary processing, smelting, or refining of raw mineral resources, including phosphate, lime, and cement plants; sand and gravel plants; copper, zinc, lead, and aluminum smelters; and other metal smelting and refining installations.

Petroleum Production: Extraction of crude oil and natural gas from the earth along with associated exploratory activity.

Petroleum Refining: Gas plants and refineries producing oils, gasoline, jet and diesel fuels, kerosene, paving and roofing materials, and residual products.

Logging: Operations related to the removal of standing timber, including construction of logging roads, grading and terracing, slash burning, cutting, thinning, and restocking.

Wood Products: Sawmills; planing mills; veneer and plywood plants; prefabricated structural wood and millwork plants; pole and post producers; wood preserving and miscellaneous wood product plants; pulp, paper, and paper-board mills.

Manufacturing: Production of textile mill products (apparel and other finished products); dry cleaning; furniture and fixtures, printing and publishing; chemicals, paints, and allied products; rubber and plastic products; leather goods and tanneries; stone, clay, and glass products; fabricated metal products (machinery, electrical equipment, transportation equipment); and miscellaneous manufacturing industries.

Residential: Activities and situations associated with the home and city, including domestic trash, garbage, and sewage disposal; auto junk yards, street sanitation, general housing conditions; urban, suburban and rural residential development, including second homes, summer homes, and condominiums, lawn and residence maintenance and beautification, and emissions from incinerators, furnaces, and fireplaces.

Transportation: Airports; railways; highways; roads; airline, railroad, and bus service activities, truck hauling; passenger car operation and supportive businesses such as service stations and garages, roadside advertising; roadside litter; highway maintenance; pipelines for transporting raw petroleum resources; and construction of all transportation facilities.

Communications and Utilities: Telephone and electric power transmission lines; underground cables, refined oil and natural gas lines and mains, maintenance roads and rights-of-way; microwave relay towers; radio and television transmission towers, and water mains, lines, and aqueducts.

Termal Power Generation: Activities associated with the operation and construction of steam-electric generating plants, particularly fossil fuel burning.

Recreation: Outdoor leisure-time activities and hobbies including sightseeing, hunting, fishing, camping, hiking, horseback riding, rock and fossil collecting, amateur archaeology, snowmobiling, skiing, motorcycling, golf, tennis, swimming, boating, and any cross-country vehicular travel.

Water Storage: Activities associated with major impoundments of free-flowing water for any of a number of reasons (hydropower, irrigation water storage, recreation, flood control), including dam construction and reservoir filling and discharge.

Environmental Classes

These are self-explanatory with the possible exception of "esthetics," which encompasses the general beauty and attractiveness of the environment. Esthetic quality may be degraded visually (signboards, power lines, smokestacks, clearcut or strip-mine scars), by some audible intrusustion (snowmobile or trailbike noise, chainsaws, sonic "booms"), by some unnatural odor (feedlot or sewage lagoon), or by some intangible combination of circumstances detected by the senses.

APPENDIX C

Montana Environmental Policy Act

CHAPTER 65 — MONTANA ENVIRONMENTAL POLICY ACT

Section

69-6501 Short title
69-6502. Purpose of act
69-6503 Declaration of state policy for the environment
69-6504. General directions to state agencies
69-6505 Review of statutory authority and administrative policies to determine deficiencies or inconsistencies
69-6506. Specific statutory obligations unimpaired
69-6507 Policies and goals supplementary
69-6508 Environmental quality council
69-6509 Term of office
69-6510 Meetings
69-6511 Appointment and qualifications of an executive director
69-6512. Appointment of employees
69-6513. Term and removal of the executive director
69-6514 Duties of executive director and staff
69-6515. Examination of records of government agencies
69-6516 Hearings by council — enforcement of subpoenas
69-6517 Consultation with other groups — utilization of services

69-6501. Short title. This act may be cited as the "Montana Environmental Policy Act."

History: En. Sec. 1, Ch. 238, L. 1971.

Title of Act

An act to establish a state policy for the environment and to establish an environmental quality council and setting forth its powers and duties and providing an effective date

69-6502. Purpose of act. The purpose of this act is to declare a state policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the state; and to establish an environmental quality council.

History: En. Sec. 2, Ch. 238, L. 1971

69-6503. Declaration of state policy for the environment. The legislative assembly, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the state of Montana, in cooperation with the federal government and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can coexist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Montanans

(a) In order to carry out the policy set forth in this act, it is the continuing responsibility of the state of Montana to use all practicable means, consistent with other essential considerations of state policy, to improve and coordinate state plans, functions, programs, and resources to the end that the state may—

(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations,

(2) assure for all Montanans safe, healthful, productive, and esthetically and culturally pleasing surroundings,

(3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences,

(4) preserve important historic, cultural, and natural aspects of our unique heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice,

(5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities, and

(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

(b) The legislative assembly recognizes that each person shall be entitled to a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment

History: En. Sec. 3, Ch. 238, L. 1971.

69-6504. General directions to state agencies. The legislative assembly authorizes and directs that, to the fullest extent possible,

(a) The policies, regulations, and laws of the state shall be interpreted and administered in accordance with the policies set forth in this act, and

(b) all agencies of the state shall

(1) utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision making which may have an impact on man's environment,

(2) identify and develop methods and procedures, which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations,

(3) include in every recommendation or report on proposals for projects, programs, legislation and other major actions of state government significantly affecting the quality of the human environment, a detailed statement on—

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented

Prior to making any detailed statement, the responsible state official shall consult with and obtain the comments of any state agency which has jurisdiction by law or special expertise with respect to any environmental impact involved. Copies of such statement and the comments and views of the appropriate state, federal, and local agencies, which are authorized to develop and enforce environmental standards, shall be made available to the governor, the environmental quality council and to the public, and shall accompany the proposal through the existing agency review processes.

(4) study, develop, and describe appropriate alternatives to recommend courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources.

(5) recognize the national and long-range character of environmental problems and, where consistent with the policies of the state, lend appropriate support to initiatives, resolutions, and programs designed to maximize national co-operation in anticipating and preventing a decline in the quality of mankind's world environment,

(6) make available to counties, municipalities, institutions, and individuals, advice and information useful in restoring, maintaining, and enhancing the quality of the environment,

(7) initiate and utilize ecological information in the planning and development of resource-oriented projects, and

(8) assist the environmental quality council established by section 8 (69-6508) of this act.

History: En. Sec. 4, Ch. 238, L. 1971.

69-6505. Review of statutory authority and administrative policies to determine deficiencies or inconsistencies. All agencies of the state shall review their present statutory authority, administrative regulations, and current policies and procedures for the purpose of determining whether there are any deficiencies or inconsistencies therein which prohibit full compliance with the purposes and provisions of this act and shall propose to the governor and the environmental quality council not later than July 1, 1972, such measures as may be necessary to bring their authority and policies into conformity with the intent, purposes, and procedures set forth in this act.

History: En. Sec. 5, Ch. 238, L. 1971.

69-6506. Specific statutory obligations unimpaired. Nothing in section 3 (69-6503) or 4 (69-6504 shall in any way affect the specific statutory obligations of any agency of the state

(a) to comply with criteria or standards of environmental quality,

(b) to co-ordinate or consult with any other state or federal agency, or

(c) to act, or refrain from acting contingent upon the recommendations or certification of any other state or federal agency.

History: En. Sec. 6, Ch. 238, L. 1971

69-6507. Policies and goals supplementary. The policies and goals set forth in this act are supplementary to those set forth in existing authorizations of all boards, commissions, and agencies of the state.

History: En. Sec. 7, Ch. 238, L. 1971.

69-6508. Environmental quality council. The environmental quality council shall consist of thirteen (13) members to be as follows:

(a) The governor or his designated representative shall be an ex officio member of the council and shall participate in council meetings as a regular member.

(b) Four (4) members of the senate and four (4) members of the house of representatives appointed before the sixtieth legislative day in the same manner as standing committees of the respective houses are appointed. A vacancy on the council occurring when the legislative assembly is not in session shall be filled by the selection of a member of the legislative assembly by the remaining members of the council. No more than two (2) of the appointees of each house shall be members of the same political party.

(c) Four (4) members of the general public to be appointed by the governor with the consent of the senate.

In considering the appointments of (b) and (c) above, consideration shall be given to their qualifications to analyze and interpret environmental trends and information of all kinds, to appraise programs and activities of the state government in the light of the policy set forth in section 3 (69-6503) of this act, to be conscious and responsive to the scientific, economic, social, esthetic, and cultural needs and interests of the state, and to formulate and recommend state policies to promote the improvement of the quality of the environment.

History: En. Sec. 8, Ch. 238, L. 1971.

69-6509. Term of office. The four (4) council members from the house of representatives shall serve for two (2) years and may be reappointed. Two (2) council members from the senate, one from each political party, and two (2) council members from the general public shall serve for four (4) years, and these members may be reappointed for a two (2) year term. Two (2) council members from the senate, one from each political party, and two (2) council members from the general public shall serve for two (2) years and these members may be reappointed for a four (4) year term. In no case shall a member of the council serve more than six (6) years.

The council shall elect one of its members as chairman and such other officers as it deems necessary. Such officer shall be elected for a term of two (2) years.

History: En. Sec. 9, Ch. 238, L. 1971.

69-6510. Meetings. The council may determine the time and place of its meetings but shall meet at least once each quarter. Each member of the council shall, unless he is a full-time salaried officer or employee of this state, be paid twenty-five dollars ($25) for each day in which he is actually and necessarily engaged in the performance of council duties, and shall also be reimbursed for actual and necessary expenses incurred while in the performance of council duties. Members who are full-time salaried officers or employees of this state may not be compensated for their service as members, but shall be reimbursed for their expenses.

History: En. Sec. 10, Ch. 238, L. 1971.

69-6511. Appointment and qualifications of an executive director. The council shall appoint the executive director and set his salary. The executive director shall hold a degree from an accredited college or university with a major in one of the several environmental sciences and shall have at least three (3) years of responsible experience in the field of environmental management.

He shall be a person who, as a result of his training, experience, and attainments, is exceptionally well qualified to analyze and interpret environmental trends and information of all kinds; to appraise programs and activities of the state government in the light of the policy set forth in section 3 (69-6503) of this act, to be conscious of and responsive to the scientific, economic, social, esthetic, and cultural needs and interests of the state; and to formulate and recommend state policies to promote the improvement of the quality of the environment.

History: En. Sec. 11, Ch. 238, L. 1971

69-6512. Appointment of employees. The executive director, subject to the approval of the council may appoint whatever employees are necessary to carry out the provisions of this act, within the limitations of legislative appropriations.

History. En. Sec. 12, Ch. 238, L. 1971

69-6513. Term and removal of the executive director. The executive director is solely responsible to the environmental quality council. He shall hold office for a term of two (2) years beginning with July 1 of each odd-numbered year. The council may remove him for misfeasance, malfeasance or nonfeasance in office at any time after notice and hearing.

History. En. Sec. 13, Ch. 238, L. 1971.

69-6514. Duties of executive director and staff. It shall be the duty and function of the executive director and his staff

(a) to gather timely and authoritative information concerning the conditions and trends in the quality of the environment both current and prospective, to analyze and interpret such information for the purpose of determining whether such conditions and trends are interfering, or are likely to interfere, with the achievement of the policy set forth in section 3 (69-6503) of this act, and to compile and submit to the governor and the legislative assembly studies relating to such conditions and trends,

(b) to review and appraise the various programs and activities of the state agencies in the light of the policy set forth in section 3 (69-6503) of this act for the purpose of determining the extent to which such programs and activities are contributing to the achievement of such policy, and to make recommendations to the governor and the legislative assembly with respect thereto,

(c) to develop and recommend to the governor and the legislative assembly, state policies to foster and promote the improvement of environmental quality to meet the conservation, social, economic, health, and other requirements and goals of the state;

(d) to conduct investigations, studies, surveys, research, and analyses relating to ecological systems and environmental quality;

(e) to document and define changes in the natural environment, including the plant and animal systems, and to accumulate necessary data and other information for a continuing analysis of these changes or trends and an interpretation of their underlying causes;

(f) to make and furnish such studies, reports thereon, and recommendations with respect to matters of policy and legislation as the legislative assembly requests,

(g) to analyze legislative proposals in clearly environmental areas and in other fields where legislation might have environmental consequences, and assist in preparation of reports for use by legislative committees, administrative agencies, and the public

(h) to consult with, and assist legislators who are preparing environmental legislation, to clarify any deficiencies or potential conflicts with an overall ecologic plan.

(i) to review and evaluate operating programs in the environmental field in the several agencies to identify actual or potential conflicts, both among such activities, and with a general ecologic perspective, and to suggest legislation to remedy such situations.

(j) to transmit to the governor and the legislative assembly annually, and make available to the general public annually, beginning July 1, 1972, an environmental quality report concerning the state of the environment which shall contain

(1) the status and condition of the major natural, man-made, or altered environmental classes of the state, including, but not limited to, the air, the aquatic, including surface and ground water, and the terrestrial environment, including, but not limited to, the forest, dry land, wetland, range, urban, suburban, and rural environment,

(2) the adequacy of available natural resources for fulfilling human and economic requirements of the state in the light of expected population pressures

(3) current and foreseeable trends in the quality, management and utilization of such environments and the effects of those trends on the social, economic, and other requirements of the state in the light of expected population pressures,

(4) a review of the programs and activities (including regulatory activities) of the state and local governments, and nongovernmental entities or individuals, with particular reference to their effect on the environment and on the conservation, development and utilization of natural resources, and

(5) a program for remedying the deficiencies of existing programs and activities, together with recommendations for legislation

History. En. Sec. 14, Ch. 238, L. 1971

69-6515. Examination of records of government agencies. The environmental quality council shall have the authority to investigate, examine and inspect all records, books and files of any department, agency, commission, board or institution of the state of Montana

History. En. Sec. 15, Ch. 238, L. 1971

69-6516. Hearings by council — enforcement of subpoenas. In the discharge of its duties the environmental quality council shall have authority to hold hearings, administer oaths, issue subpoenas, compel the attendance of witnesses, and the production of any papers, books, accounts, documents and testimony, and to cause depositions of witnesses to be taken in the manner prescribed by law for taking depositions in civil actions in the district court. In case of disobedience on the part of any person to comply with any subpoena issued on behalf of the council, or any committee thereof, or of the refusal of any witness to testify on any matters regarding which he may be lawfully interrogated, it shall be the duty of the district court of any county or the judge thereof, on application of the environmental quality council to compel obedience by proceedings for contempt as the case of disobedience of the requirements of a subpoena issued from such court on a refusal to testify therein.

History. En. Sec. 16, Ch. 238, L. 1971

69-6517. Consultation with other groups — utilization of services. In exercising its powers, functions, and duties under this act, the council shall

(a) consult with such representatives of science, industry, agriculture, labor, conservation organizations, educational institutions, local governments and other groups, as it deems advisable, and

(b) utilize, to the fullest extent possible, the service, facilities, and information (including statistical information) of public and private agencies and organizations, and individuals, in order that duplication of effort and expense may be avoided, thus assuring that the commission's activities will not unnecessarily overlap or conflict with similar activities authorized by law and performed by established agencies

History. En. Sec. 17, Ch. 238, L. 1971

Effective Date
Section 18 of Ch. 238, Laws 1971 provided the act should be in effect from and after its passage and approval. Approved March 9, 1971

APPENDIX D

Revised Guidelines*

For Environmental Impact Statements required by the Montana Environmental Policy Act of 1971

Adopted by Environmental Quality Council, July 21, 1972

1. PURPOSE

The purpose of Section 69-6504 (b) (3) of the Montana Environmental Policy Act (MEPA) and of these guidelines is to incorporate into the agency decision-making process careful and thorough consideration of the environmental effects of proposed actions, and to assist agencies in implementing the MEPA in a uniform, deliberate manner

2. POLICY

a. As early as possible and in all cases prior to any agency decision concerning major action or recommendation or a proposal for legislation that significantly affects the environment, State agencies shall, in consultation with other appropriate agencies and individuals, both in the public and private sectors, assess in detail the potential environmental impact in order that adverse effects are avoided and environmental quality is maintained, enhanced, or restored to the fullest extent practicable. In particular, it is especially important that alternative actions that will minimize adverse impacts shall be explored and both the long and short-range implications to the human environment and to nature shall be evaluated in order to avoid, to the fullest extent practicable, undesirable consequences for the environment as a whole.

The language in Section 69-6504 is intended to assure that all agencies of the State shall comply with the directives set out in said Section "to the fullest extent possible" under their statutory authorizations and that no agency shall utilize an excessively narrow construction of its existing statutory authorizations to avoid compliance.

b. For the purpose of implementation of the MEPA, the term "human environment" is to be broadly construed to include not only social, economic, cultural, and esthetic factors, but is also, and particularly, intended to include the biophysical properties of natural ecosystems, including plants, animals, man, their relationship with each other, and with all environmental components of air, water, and land: otherwise known as "ecology".

3. AGENCY PROCEDURES

a. Each agency shall establish its own formal procedures for:

(1) Identifying those agency actions and decisions requiring environmental statements, the appropriate time prior to decision for the consultation required by Section 69-6504 (b) (3) and the agency review process for which environmental statements are to be available;

(2) Obtaining information required in their preparation,

(3) Designating the officials who are to be responsible for the statements,

(4) Consulting with and taking account of the comments of appropriate agencies, and the public, whether or not a statement is prepared; and

(5) Meeting the requirements of Section 69-6504 (b) (3) for providing timely public information on plans and programs with environmental impact, including procedures responsive to Section 8 of these guidelines. These procedures should be consistent with the guidelines contained herein. Each agency should file a copy of all such procedures with the Environmental Quality Council (EQC) which will provide advice to agencies in the preparation of their procedures and guidance on the application and interpretation of the Council's guidelines.

In addition, it is suggested that each agency prepare a flow chart outlining its EIS procedure. The flow chart should include all points of review and decision-making, and divisions of individual responsibility.

4. STATE AGENCIES INCLUDED

Section 69-6504 (b) (3) applies to all agencies of the State government. Each agency shall comply with the requirements unless the agency demonstrates that existing law applicable to its operations expressly prohibits or makes compliance impossible.

5. ACTIONS INCLUDED

The following criteria shall be employed by agencies in deciding whether a proposed action requires the preparation of an environmental statement.

a. Actions include, but are not limited to:

(1) Recommendations or favorable reports relating to legislation, including that for appropriations. The requirement for following the Section 69-6504 (b) (3) procedure as elaborated in these guidelines applies to both

(a) agency recommendations on their own proposals for legislation, and

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*Freely adapted from the Federal guidelines as published in 36 Federal Register, 7724-7729, April 23, 1971

(b) agency reports on legislation initiated elsewhere. (In the latter case only the agency which has primary responsibility for the subject matter involved will prepare an environmental impact statement.)

(2) Projects, programs, and continuing activities directly undertaken by state agencies, supported in whole or in part through state funds or involving a state lease, permit, license, certificate or other entitlement for use,

(3) Policy, regulations, and procedure making.

b. The statutory clause "major actions of State government significantly affecting the quality of the human environment" shall be construed by agencies with a view to the overall, cumulative impact of the action proposed (and of further actions contemplated). Such actions may be localized and seemingly insignificant in their impact, but if there is a potential that the environment may be significantly affected, the statement shall be prepared.

In considering what constitutes major action significantly affecting the environment, agencies should bear in mind that the effect of many State decisions about a project or a complex of projects can be individually limited but cumulatively considerable. Examples are when one or more agencies over a period of years puts into a project individually minor but collectively major resources, or when several government agencies individually make decisions about partial aspects of a major action. The guiding principle is that the whole can be greater than the sum of the parts. The lead agency shall prepare an environmental impact statement if it is foreseeable that a cumulatively significant impact on the environment will arise from State action. "Lead agency" refers to the State agency which has primary authority for committing the State government to a course of action with significant environmental impact. As necessary, the Environmental Quality Council will assist in resolving questions of lead agency determination.

c. On predictably controversial issues, agencies shall prepare pre-draft outlines of environmental impact statements. These outlines shall be circulated in a timely fashion to selected public agencies, to selected private groups and individuals, and to private groups and individuals whose interests will be significantly affected by the proposed action, for review and comment. Agencies shall give careful consideration to the comments and suggestions elicited by this process when they prepare their draft environmental impact statement.

d. When an agency responsible for the issuance of a state lease, permit, license, certificate, or other entitlement for use, should be able to foresee that the issuance of a large number of such entitlements will, cumulatively, have a significant impact upon the environment, an environmental impact statement shall be prepared. Normal agency procedures, as delineated in Section 3 above, shall be used in the preparation of such an impact statement. Information supplied by applicants for these entitlements may be used or considered in the preparation of an impact statement, but such information may not be submitted by itself in place of an impact statement.

e. Section 69-6504 of the MEPA indicates the broad range of aspects of the environment to be surveyed in any assessment of significant effect.

The MEPA also indicates that adverse significant effects include those that degrade the quality of the environment, and curtail the range of beneficial uses of the environment, and serve short-term, to the disadvantage of long-term, environmental goals. Significant effects can also include actions which may have both beneficial and detrimental effects, even if, on balance, the agency believes that the effect will be beneficial. Significant adverse effects on the quality of the human environment include both those that directly affect human beings and those that indirectly affect human beings through adverse effects on the environment.

6. CONTENT OF ENVIRONMENTAL STATEMENT

a. The following points are to be covered:

(1) A description of the proposed action including information and technical data adequate to permit a careful assessment of environmental impact by commenting agencies and the public.

(2) The probable impact of the proposed action on the environment, including impact on ecological systems. Both primary and secondary significant consequences for the environment shall be included. A primary impact is one which generally results from a project input, a secondary impact is one which generally results from a project output. Primary impacts are usually more susceptible to measurement and analysis by an agency proposing an action because the primary impacts are more immediately related to an agency's area of responsibility and expertise. Secondary impacts, on the other hand, usually require analyses by a number of agencies because they are not within any single agency's area of responsibility or expertise.

(3) Any probable adverse environmental effects which cannot be avoided, should the proposal be implemented.

(4) Alternatives to the proposed action.
Section 69-6504 (b) (3) requires the responsible agency to "study, develop, and describe appropriate alternatives to recommend courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources." A rigorous exploration and objective evaluation

of alternative actions (including no action at all) that might avoid some or all of the adverse environmental effects is essential. In addition, there should be an equally rigorous consideration of alternatives open to other authorities. Sufficient analysis of such alternatives and their costs and impact on the environment should accompany the proposed action through the agency review process in order not to foreclose prematurely options which might have less detrimental effects.

(5) The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term effects from the perspective that each generation is trustee of the environment for succeeding generations.

(6) Any irreversible and irretrievable commitments of natural and economic resources which would be involved in the proposed action should it be implemented. This requires the agency to identify the extent to which the action curtails the range of alternative and beneficial uses of the environment.

(7) A discussion of problems and objections raised by other agencies and by private organizations and individuals in the review process and the disposition of the issues involved. This section may be submitted separately from the draft.

(8) Insofar as it is practicable, a balancing of the economic benefits to be derived from a proposal with environmental costs.

(9) A listing of all agency personnel having chief responsibility for the preparation of the statement; a brief account of the formal education, training, and professional experience of such personnel; and a description of the sources of data, research or field investigation on which the statement and its conclusions are based.

b. Each environmental statement shall be prepared in accordance with the precept in Section 69-6504 (b)(1) that all agencies "utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and decision making which may have an impact on man's environment."

c. Where an agency follows a practice of declining to favor an alternative until public hearings have been held on a proposed action, a draft environmental statement may be prepared and circulated, indicating that two or more alternatives are under consideration. Of necessity, this commits the agency to the preparation and circulation of a statement indicating its choice of a final alternative.

d. Agencies which are required to submit statements under Section 102 (2) (c) of the National Environmental Policy Act may, with EQC approval, substitute copies of that statement in lieu of the Section 69-6504 (b) (3) requirement of the MEPA.

e. Appendix I prescribes the form of the draft environmental statement.

7. STATE AGENCIES TO BE CONSULTED IN CONNECTION WITH PREPARATION OF ENVIRONMENTAL IMPACT STATEMENTS.

A state agency considering an action requiring an environmental statement for which it takes primary responsibility shall consult with and obtain the comment on the environmental impact of the action of state agencies or institutions with jurisdiction by law or special expertise with respect to any environmental impact involved.

In addition, any state agency responsible for a draft environmental statement may seek comment from appropriate federal and local agencies, from private individuals, organizations and institutions, and in particular from private parties whose interests are likely to be significantly affected by the proposed action.

Agencies seeking comment shall determine which one or more of the agencies or institutions are appropriate to consult on the basis of the areas of expertise. It is recommended that these agencies and institutions establish contact points for providing comments on the environmental statements and that departments from which comment is solicited coordinate and consolidate the comments of their component entities. It is further recommended that each agency establish a "fund file" of expertise available from the public and private sectors. The requirement in Section 69-6504 (b) (3) to obtain comment from state agencies having jurisdiction or special expertise is in addition to any specific statutory obligation of any state agency to coordinate or consult with any other agency. Agencies seeking comment shall establish time limits of not less than thirty (30) days for reply, after which it may be presumed, unless the agency consulted requires a specified extension of time, that the agency consulted has no comment to make. Agencies seeking comment should endeavor to comply with requests for extensions of time up to fifteen (15) days. Failure of EQC to publicly comment on any agency's environmental statement does not imply tacit approval of that agency action.

8. USE OF STATEMENTS IN AGENCY REVIEW PROCESSES: DISTRIBUTION TO ENVIRONMENTAL QUALITY COUNCIL: AVAILABILITY TO PUBLIC.

a. Agencies will need to identify at what state or stages of a series of actions relating to a particular matter the environmental statement procedures of these guidelines will be applied. It will often be necessary to use the procedures both in the development of a state program and in the review of proposed projects within the program. The principle to be applied is to obtain views of other agencies and the public at the earliest feasible time in the discussion and development of program and project proposals. Care should be taken to avoid duplication but when action is considered which differs significantly from other actions already reviewed pursuant to Section 69-6504 (b) (3) of the MEPA, an environmental statement shall be provided.

b. Two (2) copies of draft environmental statements, and two (2) copies of the final text of environmental statements (if prepared) together with all comments received thereon by the responsible agency from all other agencies and from private organizations and individuals, shall be supplied to the office of the Executive Director of the Environmental Quality Council. It is important that draft environmental statements be prepared and circulated for comment and furnished to the Environmental Quality Council, the Governor, and the public at the earliest possible point in the agency review process in order to permit meaningful consideration of the environmental issues before an action is taken. It is not the intent of the MEPA that the environmental statement be written to justify decisions already made. No administrative action subject to Section 69-6504 (b) (3) shall be taken sooner than sixty (60) days after a draft environmental statement has been circulated for comment, furnished to the Council and except where advance public disclosure will result in significantly increased costs of procurement to the government, made available to the public pursuant to these guidelines. If the originating agency has a full and good faith consideration of the environment in its plans, and if this is reflected in favorable comments from review agencies and the public, the draft statement may be considered as satisfying the requirement of MEPA for a detailed statement. Agencies satisfying the requirement of MEPA with the draft statement must submit two (2) copies of all comments received thereon together with formal notification of the final decision on the proposed action. Agencies must furnish the same information (final decision and all comments on draft) to all commenting entities, whether public or private, as a logical termination to the process. In cases where the final environmental statement is required administrative action shall not be taken sooner than thirty (30) days after the final text has been made available to the Council and the public. If the final text of an environmental statement is filed within sixty (60) days after a draft statement has been circulated for comment, furnished to the Council and made public pursuant to this section of these guidelines, the thirty (30) day period and sixty (60) day period may run concurrently to the extent that they overlap.

c. With respect to recommendations or reports on proposals for legislation to which Section 69-6504 (b) (3) applies, a draft environmental statement may be furnished to the appropriate legislative committee and made available to the public pending transmittal of the comments as received and the final text, if required.

d. All agencies shall make available to the public all the reports, studies, and other documents that may and should underlie the draft and final impact statements and comments.

e. Where emergency circumstances make it necessary to take an action with significant environmental impact without observing the provisions of these guidelines concerning minimum periods for agency review and advance availability of environmental statements, the agency proposing to take the action shall consult with the EQC about alternative arrangements. Similarly, where there are over-riding considerations of expense to the state or impaired program effectiveness, the responsible agency shall consult with the EQC concerning appropriate modifications of the minimum period.

f. In accord with the MEPA, agencies have an affirmative responsibility to develop procedures to insure the fullest practicable provision of timely public information and understanding of agency plans and programs with environmental impact in order to obtain the view of interested and significantly affected parties.

These procedures shall include, whenever appropriate, provision for public hearings, and shall provide the public with relevant information including information on alternative courses of action. Agencies which hold hearings on proposed administrative actions or legislation shall make the draft environmental statement available to the public at least thirty (30) days prior to the time of the relevant hearings. Hearings shall be preceded by adequate public notice and information to identify the issues and to obtain the comments provided for in the guidelines and should in all ways conform to those procedures outlined in the Montana Administrative Procedure Act, where applicable, R.C.M. 1947, 82-4201, et seq.

g. The agency which prepared the environmental statement is responsible for making the statement and the comments received available to the public, including inter-agency memoranda when such memoranda transmit comments of agencies upon the environmental impact of proposed actions subject to Section 69-6504 (b) (3).

h. Agency procedures prepared pursuant to Section 3 of these guidelines shall implement these public information requirements and shall include arrangements for availability of environmental statements and comments at the head and other appropriate offices of the responsible agency.

9. APPLICATION OF SECTIONS 69-6504 (b) (3) PROCEDURE TO EXISTING PROJECTS AND PROGRAMS.

The Section 69-6504 (b) (3) procedure shall be applied to major state actions having a significant effect on the environment even though they arise from projects or programs initiated prior to enactment of the MEPA on March 9, 1971. Where an agency demonstrates that it is not practicable to reassess the basic course of action, it is still important that further incremental major actions be shaped so as to minimize adverse environmental consequences. It is also important in further action that account be taken of environmental consequences not fully evaluated at the outset of the project or program.

10. SUPPLEMENTARY GUIDELINES, EVALUATION OF PROCEDURES.

These revised guidelines reflect the experience of pertinent State agencies and the EQC subsequent to the time the interim guidelines were issued almost a year ago. It is believed that this experience has made the guidelines more helpful and comprehensive. As more experience is gained, and as more comments are received, these guidelines will, from time to time, be further revised.

Agencies are encouraged to conduct an ongoing assessment of their experience in the implementation of the Section 69-6504 (b) (c) provisions of the MEPA and in conforming with these guidelines. The EQC will welcome comments on these areas at any time, but it would especially like to have such comments by December 31, 1972. Such comments should include an identification of the problem areas and suggestions for revision or clarification of these guidelines to achieve effective coordination of views on the environmental factors (and alternatives, wherever appropriate) of proposed actions without imposing unproductive administrative procedures.

APPENDIX I OF GUIDELINES

The environmental statement submitted to the Environmental Quality Council should cover the following items:

(Check one) ( ) Draft
( ) Final Environmental Statement

Name of responsible state agency (with name of operating division where appropriate.)

1. Name of action (Check one)
   ( ) Administrative Action
   ( ) Legislative Action

2. Description of action indicating what geographic area or political subdivision is particularly affected.

3. Environmental impact and adverse environmental effects.

4. List alternatives considered

5. The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity.

6. Any irreversible and irretrievable commitments of resources.

7. (a) (For draft statements) List all agencies from which comments have been requested.

   (b) (For final statements) List all agencies and sources from which written comments have been received.

8. Date draft statement and final statement was made available to the Governor, the Environmental Quality Council, and public.

Draft environmental statements should be concise, but in sufficient detail to allow a reviewer with appropriate expertise to grasp the essence of the action and comment intelligently.

In cases where final environmental statements are prepared, this format should be followed considering in detail the points covered in Section 6 of these guidelines.

APPENDIX E

Documents Submitted In Compliance with MEPA*

Lead Agency	Environmental Impact Statements	Negative Declarations**
Aeronautics Commission		3
Department of Fish and Game	19	3
Department of Health and Environmental Sciences	23	
Department of Highways	11	45
Department of Natural Resources and Conservation	3***	1
Department of State Lands	5	
Montana State University	3	

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* Received before June 30, 1972

** A written document in support of a determination that, should the proposed action be taken, the anticipated effects upon the human environment will not be significant

*** Includes a draft statement sent directly from South Dakota School of Mines regarding a weather modification project affecting Richland and Wibaux counties under permit from Department of Natural Resources and Conservation

APPENDIX F

Environmental Quality Council Position Paper

Introduction

The Montana Environmental Policy Act, enacted by the 1971 legislative assembly, became effective on March 9, 1971, when it was signed by the governor.

A thirteen-member Environmental Quality Council was created by the act to implement the policy it established and maintain an overview of those actions of state government with significant environmental consequences. The Council, composed of four senators, four representatives, four public members and the governor's representative, is an arm of the legislature with public participation and executive liaison.

Among its duties, the council has a responsibility "to enrich the understanding of ecological systems," and to make available "advice and information useful in restoring, maintaining and enhancing the quality of the environment" in order to "create and maintain conditions under which man and nature can coexist in productive harmony."

The council recognizes that the ultimate responsibility for maintenance and enhancement of environmental quality rests with an informed public. To this end, the council intends to issue from time to time statements on environmental matters which elucidate the philosophy underlying the Montana Environmental Policy Act.

The first of these position papers proposes an environmental quality premise for Montana's future development.

An Environmental Quality Premise For Montana

"Montana could be a place for the reorientation of civilization in the United States." *Harold Wilm*

Montana has perhaps the last great reserve of high-quality living space left in the United States. Endowed with abundant natural resources, this may be our most valuable resource. This priceless environmental heritage remains unblighted to a degree undreamed of elsewhere in this country.

Montana still possesses a quality of life and a quality of natural living space which will be forever unattainable in other states ravaged by the destructive development of earlier eras.

Montana yet has the unique opportunity of arresting its localized environmental cancer and restoring the health and productivity of the infected areas. Pollution has not yet become so pervasive in our state as to irreversibly impair the life-supporting natural systems which sustain human life and wildlife alike.

Health is the capacity for self-renewal. Montana still retains unimpaired this capacity for self-renewal of its natural communities of plants and animals. The natural systems of air, water, and soil on which they depend remain essentially intact.

While the living ecosystems of the state still maintain their integrity, we can elect to harmoniously intermesh human technology with the systems of nature in a sustained and productive coexistence. Sustained economic productivity is dependent upon maintained environmental integrity.

People and corporations are going to discover this state. Quality attracts quality. Our efforts to maintain environmental quality will assure that we attract those people and corporations who will add most to the life of the state.

Montanans have both the ability and the determination to go beyond repair and restoration. We have a fleeting opportunity to enhance the livability of our environment.

We are now aware, as earlier generations in other places were unaware, of the interdependent links between a healthy natural environment and human well-being.

We have the knowledge, we have observed the pitfalls. We must accept the responsibility as trustees of the environment to assure its health and productivity for all Montanans, for all generations, for all time.

Montana CAN be a place for the reorientation of civilization in the United States.

The effectiveness of the Environmental Quality Council in implementing the policy of Montana Environmental Policy Act can be a decisive factor in shaping a quality environment which is the essential premise for realizing this reorientation.

APPENDIX G

Resolution on Coal and Water Development

Adopted by Environmental Quality Council, April 7, 1972

The Environmental Quality Council hereby takes note of the lack of comprehensive planning for the future well-being of Montana citizens in the surge of industrial interest in development of Montana's coal and water resources. In recognition of this situation, the Environmental Quality Council urges Governor Forrest H. Anderson to appoint and convene at an early date an interagency task force on coal development to guide and direct comprehensive planning incorporating consideration of the social, economic, and environmental well-being of Montana people in present and future generations. To be comprehensive such planning must include provisions for (1) industrial systems, (2) agricultural systems, (3) residential systems, (4) commercial systems, (5) educational systems, (6) park and recreation systems, (7) a system of cultural amenities, (8) a communication system, (9) transportation systems, and finally, (10) a political system.

The Environmental Quality Council recommends that at least the following offices and agencies be appointed to the task force: Governor's Office, Department of Natural Resources and Conservation, Department of Health and Environmental Sciences, Department of State Lands, Department of Planning and Economic Development, Department of Fish and Game, Department of Highways, Bureau of Mines and Geology, Department of Revenue, Department of Public Instruction, University System, Agricultural Experiment Station, Legislative Council, and Environmental Quality Council.

The council recommends inclusion of representatives from federal counterpart agencies and industry as well as the formation of a citizen advisory council comprised of representatives of citizen organizations and associations.

In recognition of the key role of Montana water in impending coal development, the council recommends that the Department of Natural Resources and Conservation be appointed the coordinating agency for the task force.

(Copies of this resolution were distributed to the governor, state agencies named herein, and the Montana Congressional delegation.)

APPENDIX H

Environmental Quality Council

Program Cost Summary

July 1, 1971 - June 30, 1972

Salaries	27,135.63	
Other Compensation	2,301.11	
Employee Benefits	2,677.26	
		$32,114.00
Contracted Services	2,380.24	
Supplies	1,082.22	
Postage & Telephone	819.02	
Travel	5,169.56	
Repair & Maintenance	13.50	
Other Expense	642.64	
Equipment	2,292.91	
		12,400.09
Total — General Fund		$44,514.09
Grants: Emergency Employment Act (EEA) October 18, 1971 - June 30, 1972		
Salaries	5,916.13	
Employee Benefits	705.28	
		6,621.41
		$51,135.50

AUTHOR CREDITS

Many sections of the First Annual Environmental Quality Council Report do not include names of the staff members who authored them. Although in most cases these sections represent a cooperative contribution on the part of several members, credit should be given to the following authors for primary effort and time.

Chapter II (entire): Fletcher E. Newby, Loren L. Bahls, Thomas J. Gill, William D. Tomlinson.

Chapter III: *The 1971 Legislature: New Environmental Law and Its Implementation and Citizen Efforts*: Rick Applegate.

Chapter IV: *EQC Operations*: Fletcher E. Newby, James C. Martin; *State Agency Programs and Activities*: Rick Applegate.

Chapter V (entire): Fletcher E. Newby, Rick Applegate, James C. Martin.